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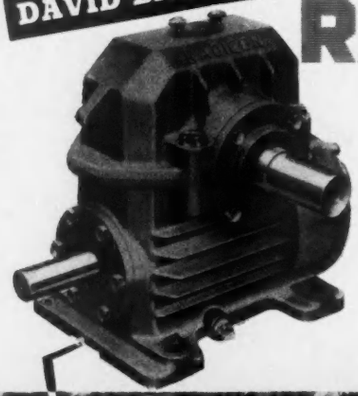

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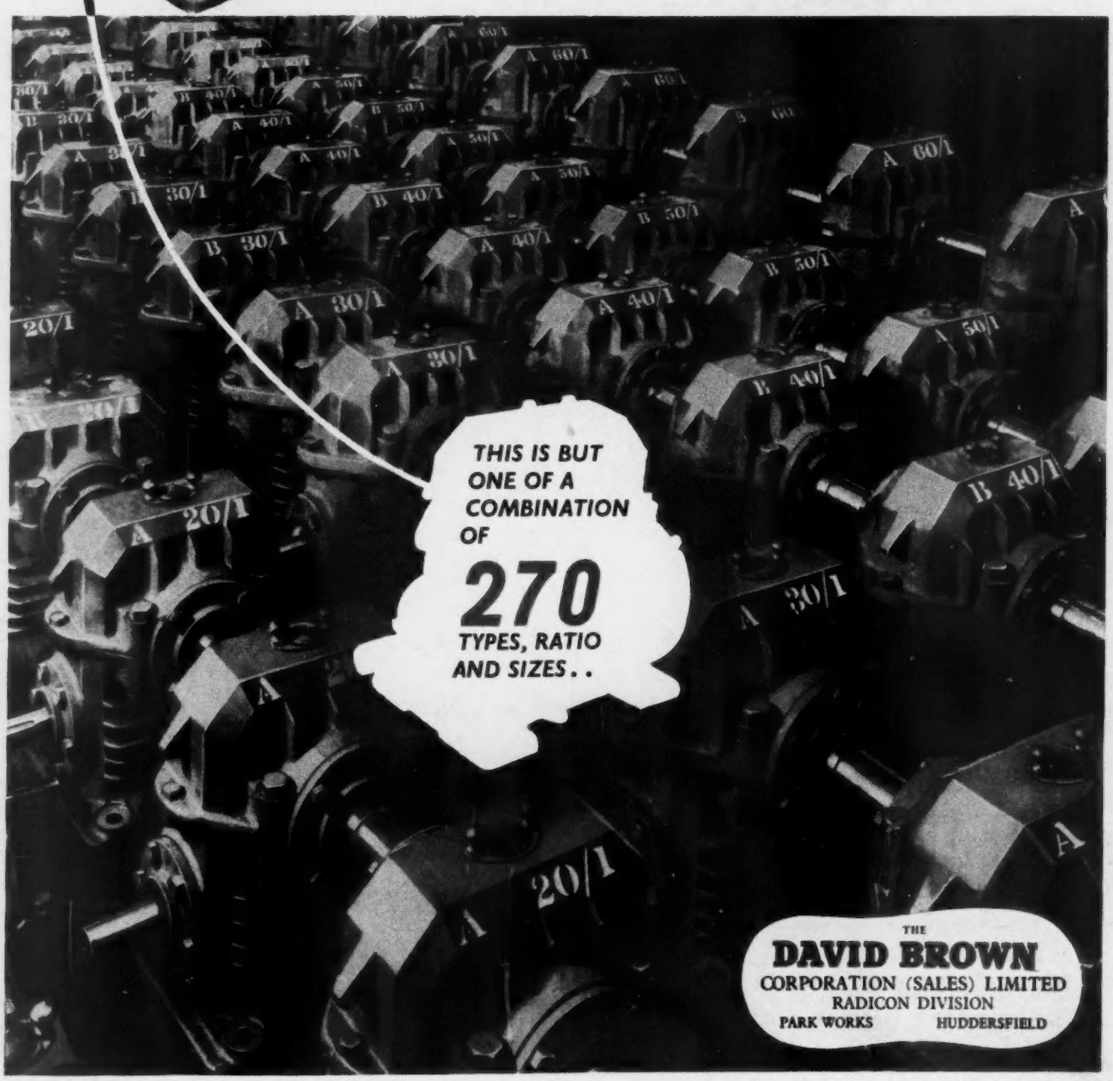

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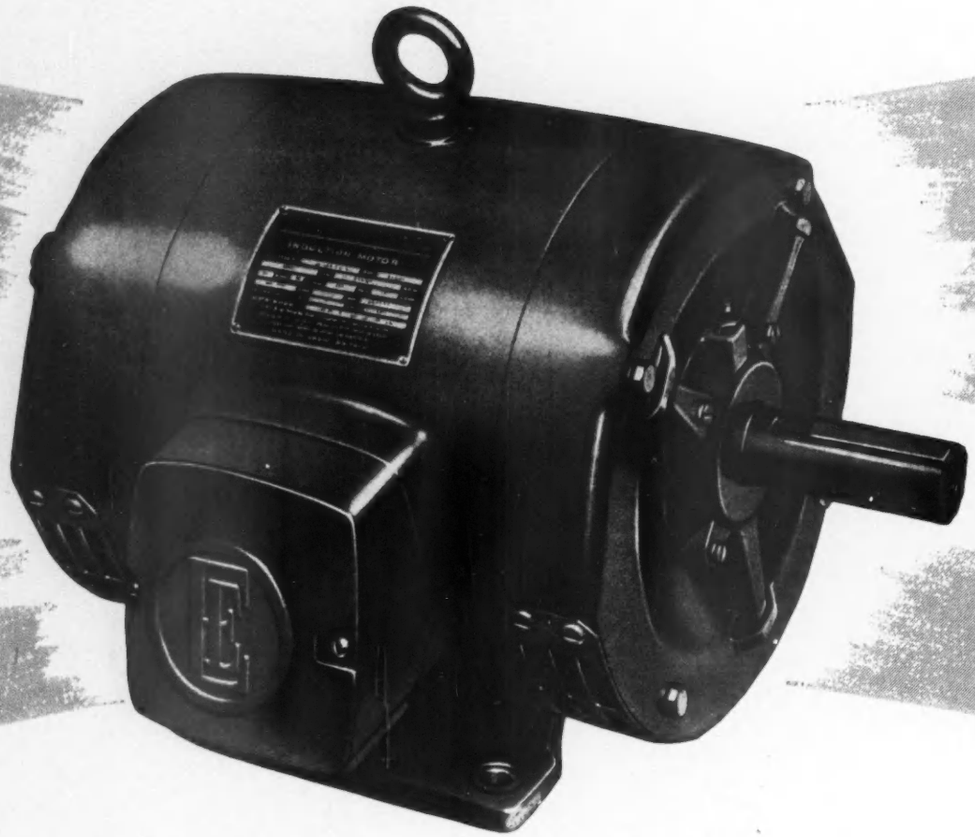

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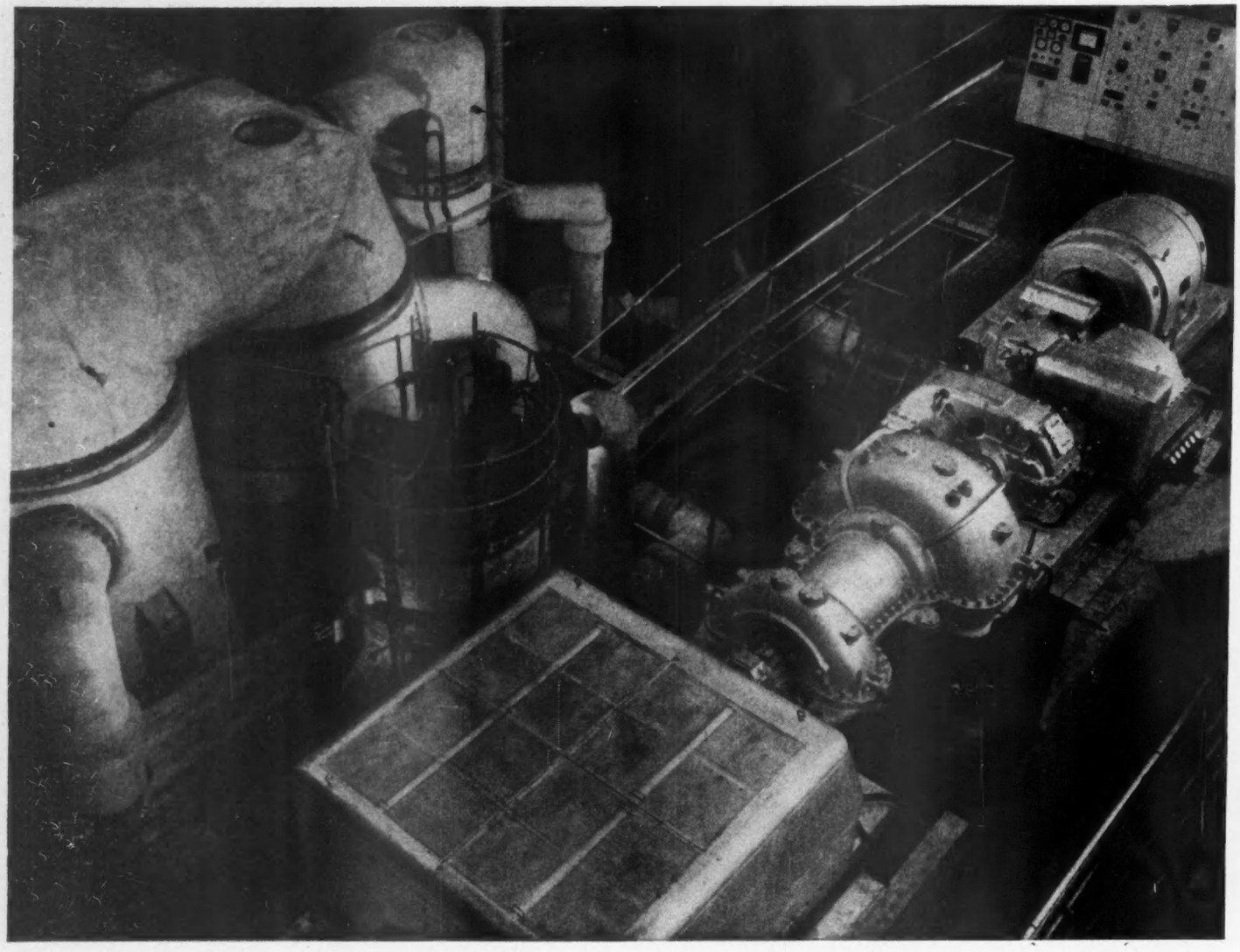

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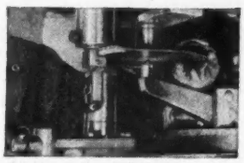

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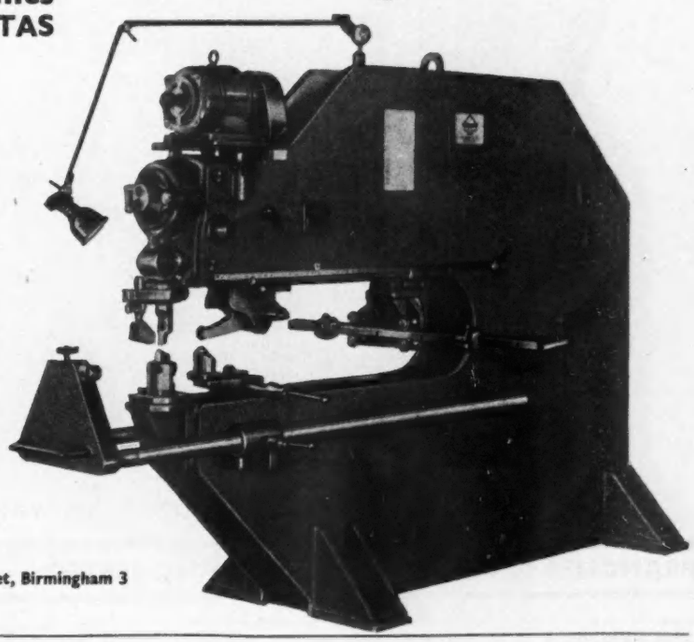

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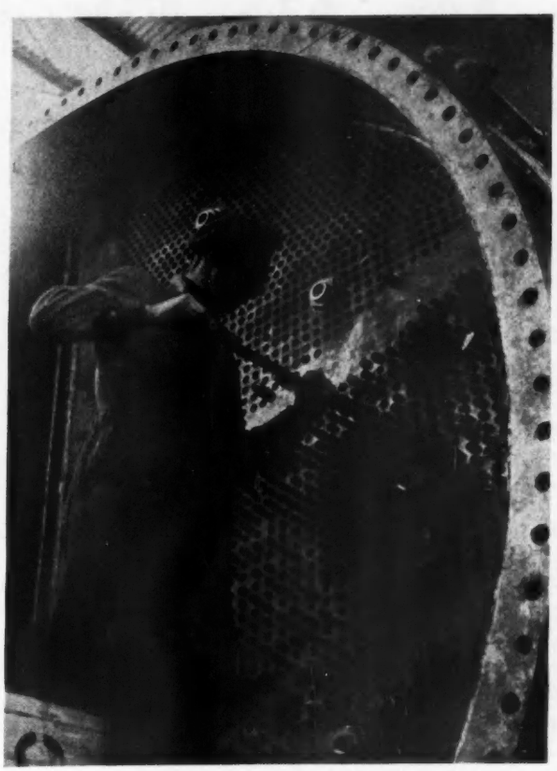

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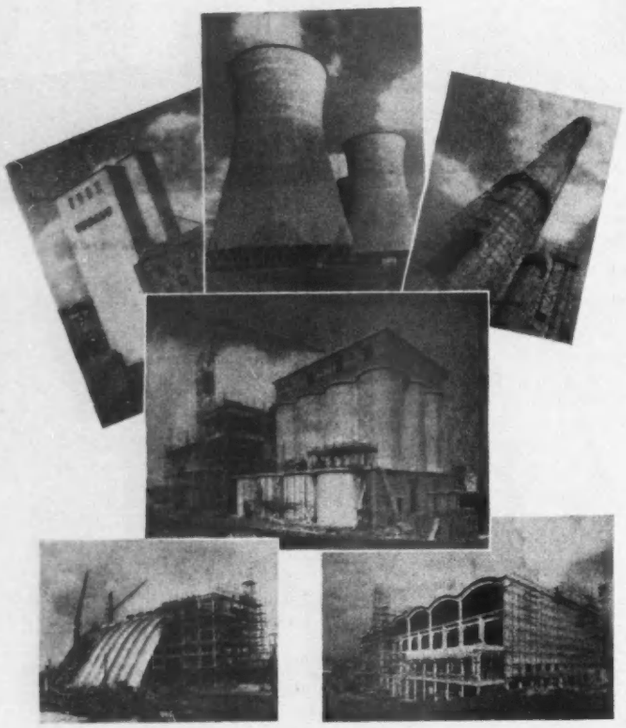

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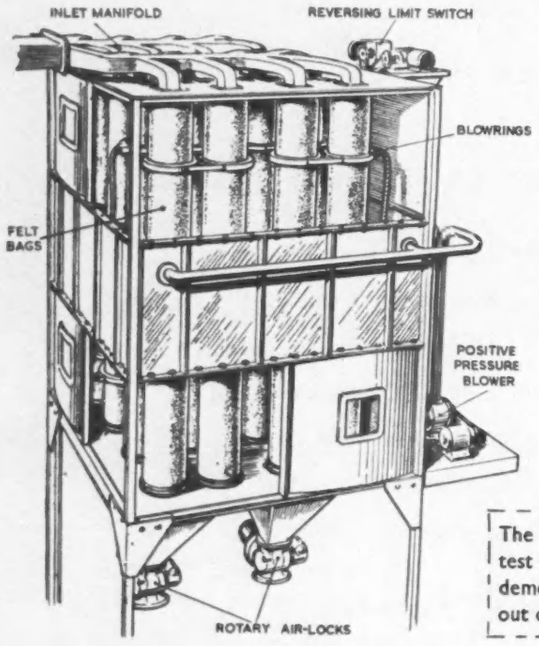

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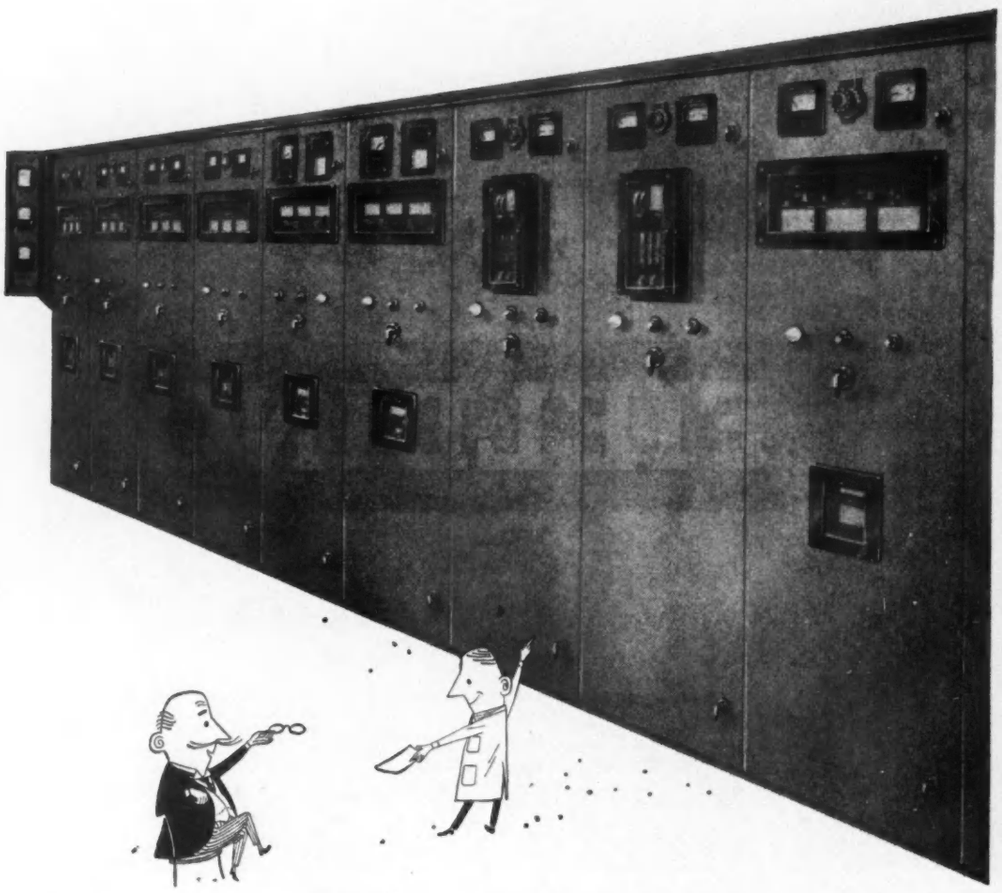

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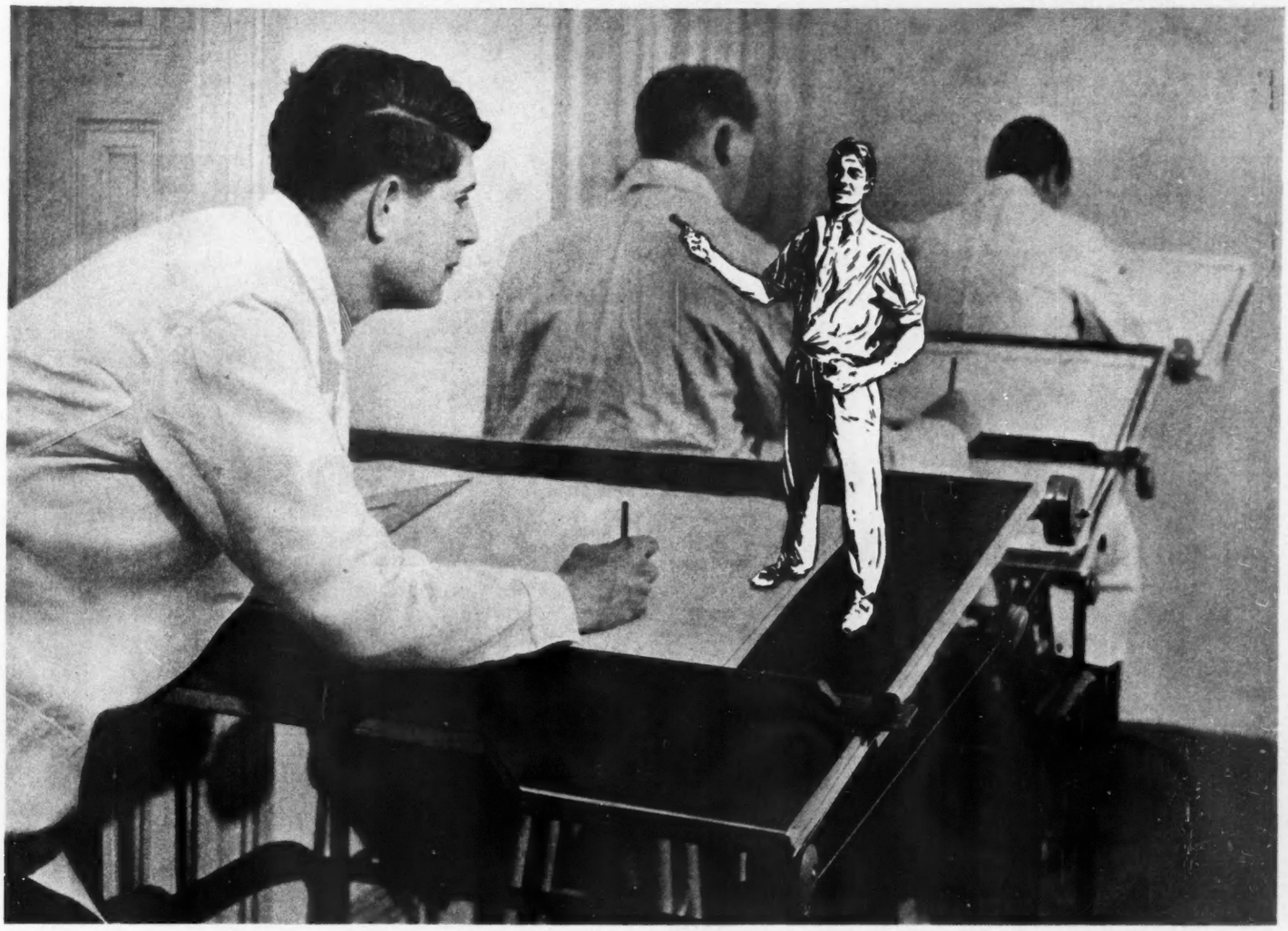

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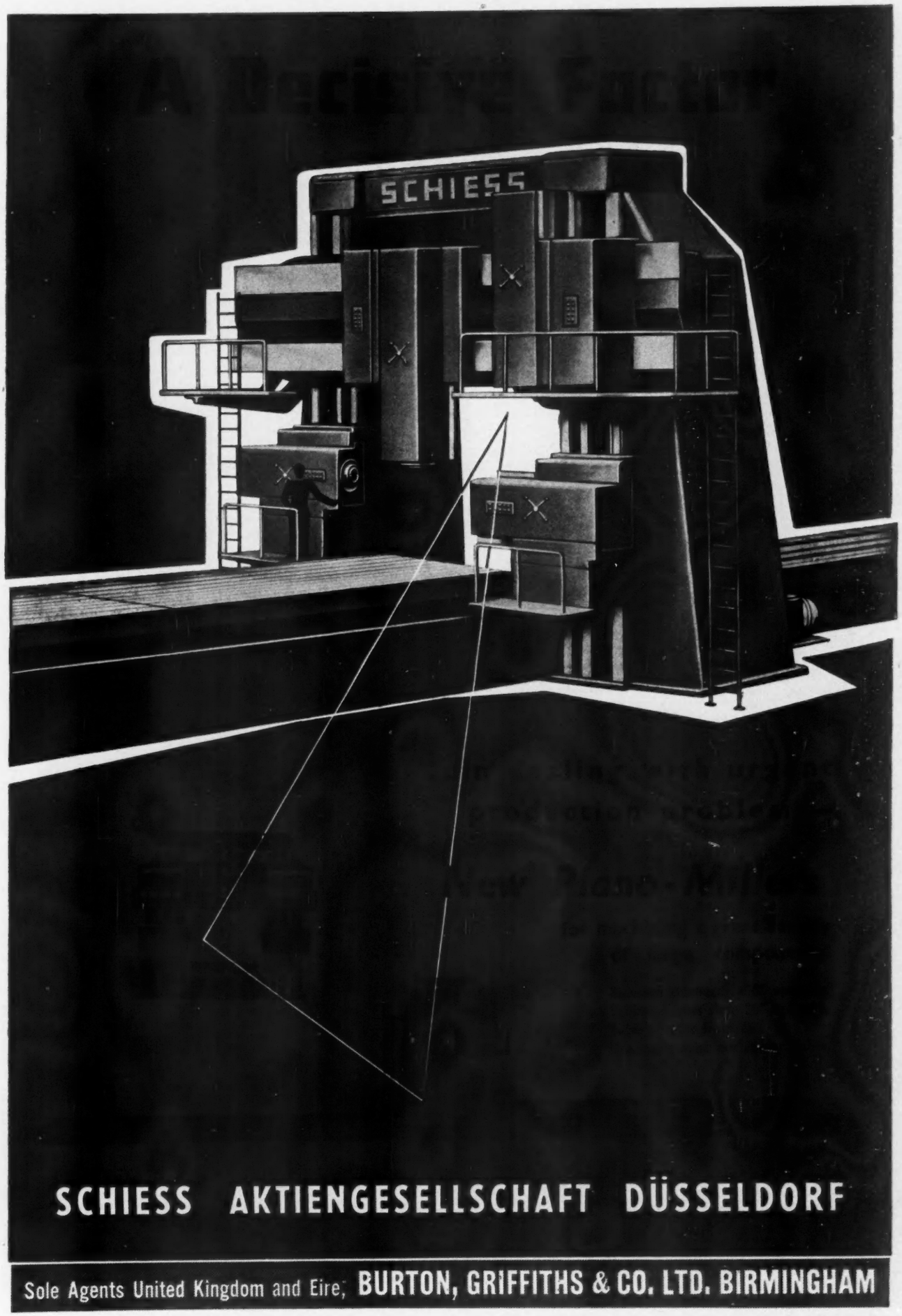

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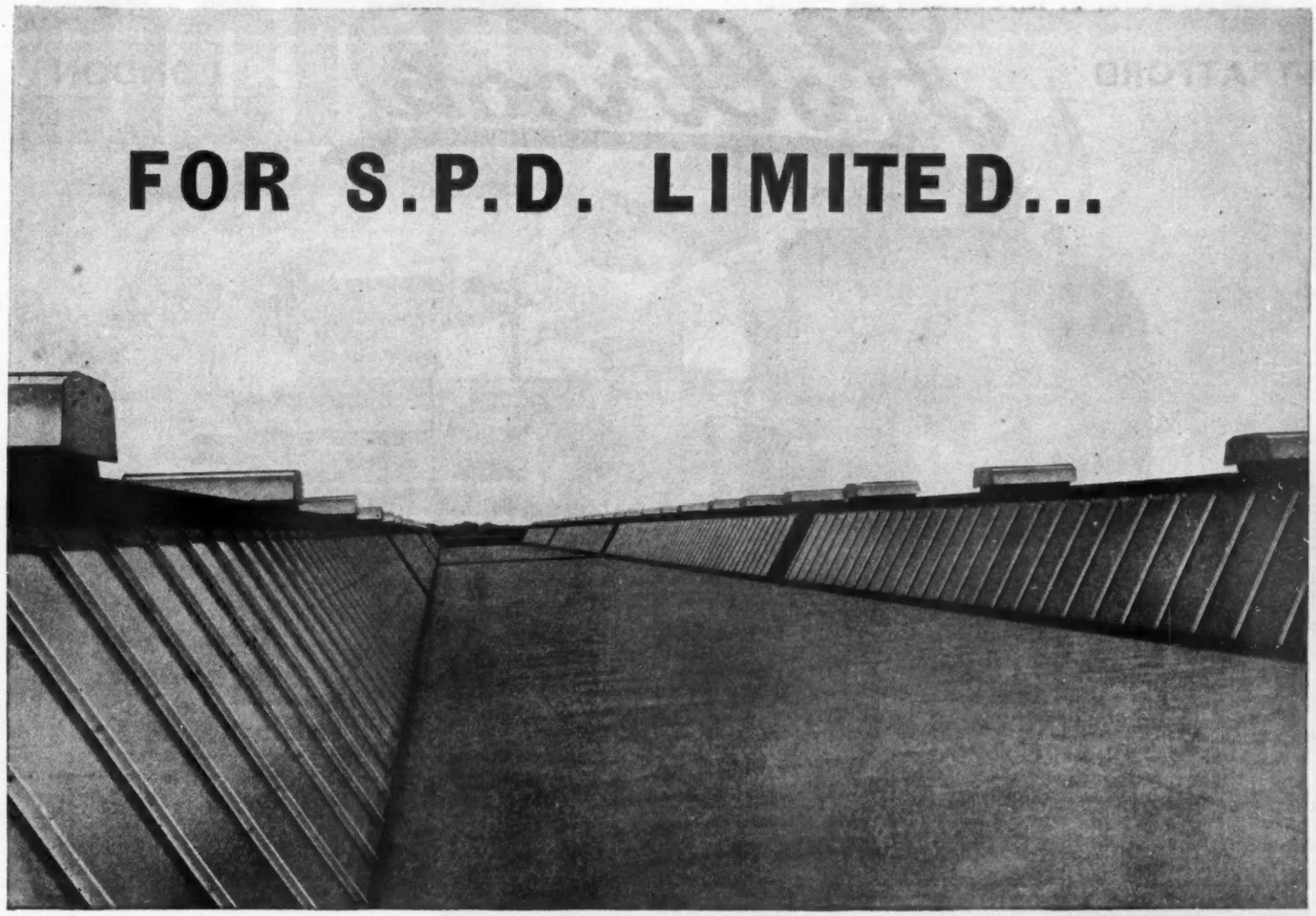

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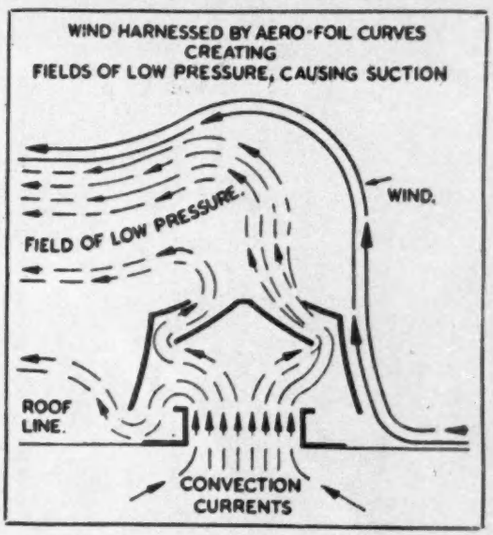

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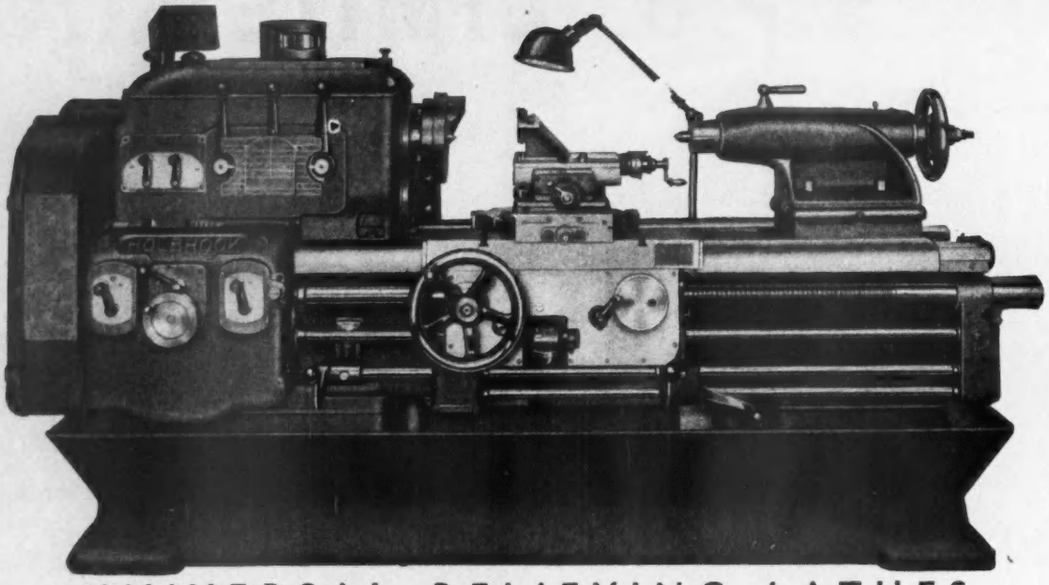

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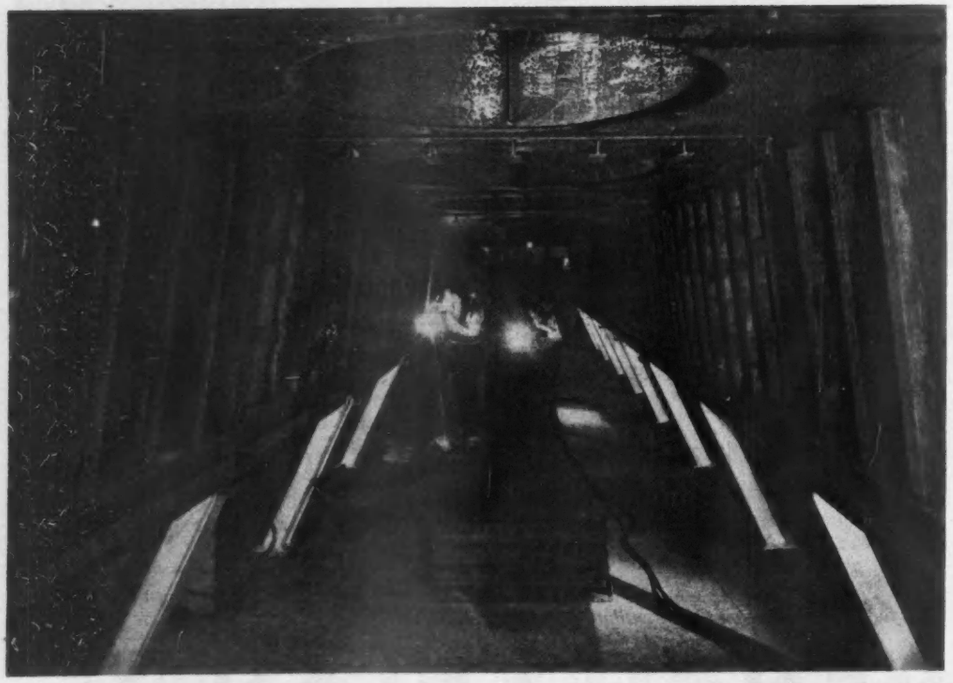

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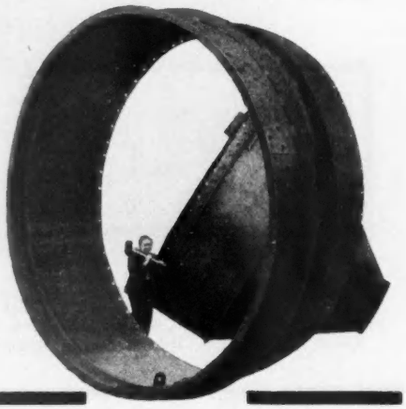

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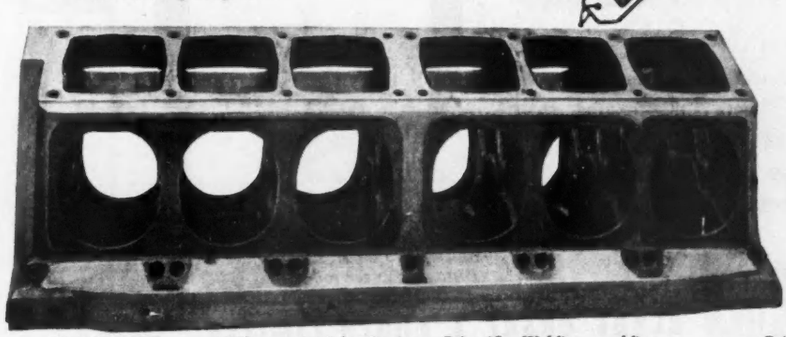

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Britains biggest Crane ..

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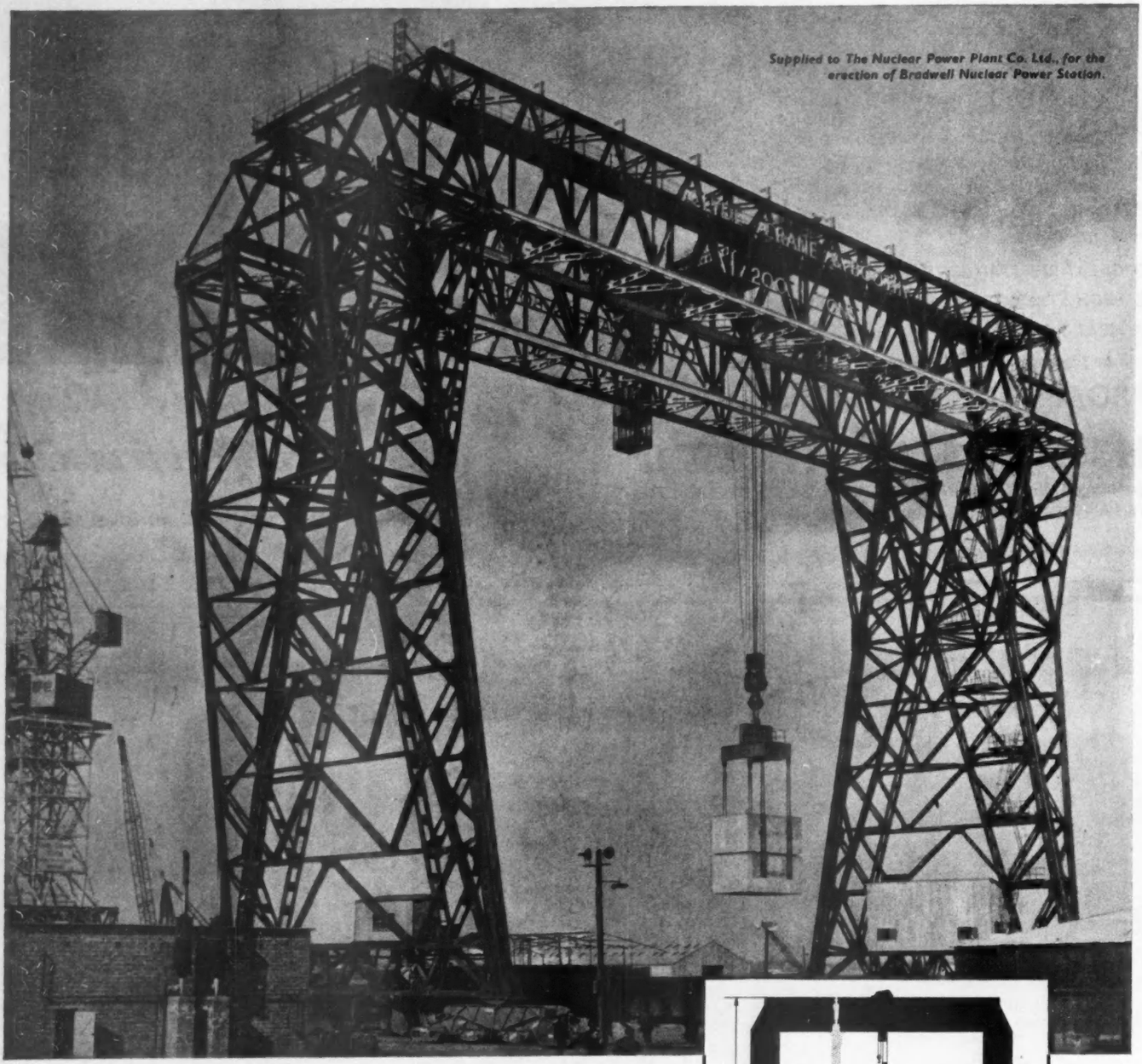
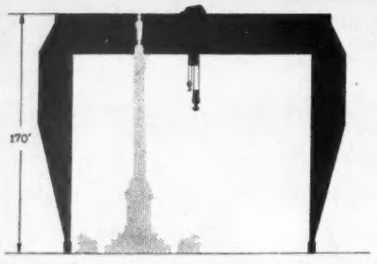


Supplied to The Nuclear Power Plant Co. Ltd., for the erection of Bradwell Nuclear Power Station.

Shown lifting concrete test blocks representing the maximum working load of 200 tons, this Goliath was built by Clyde Crane & Booth Ltd., for the erection of Bradwell Nuclear Power Station. Taking into account the lifting capacity and overall dimensions, it is believed to be the largest of its type in operation in this country and probably the world.



The Booth Goliath showing Nelsons Column on the same scale. Clearance from rail level to underside of bridge is 140'. Distance between rail centres 178'.

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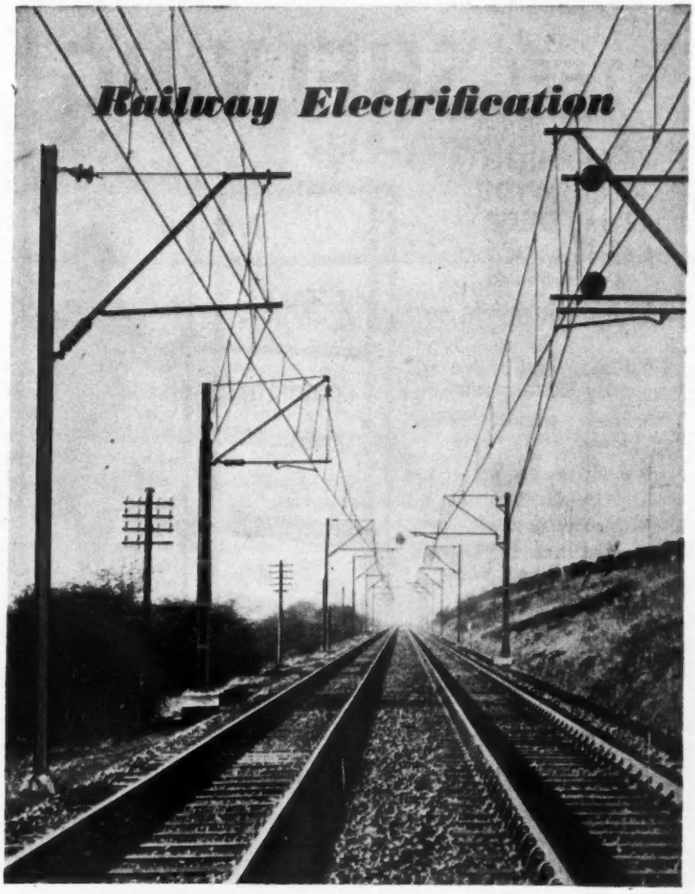

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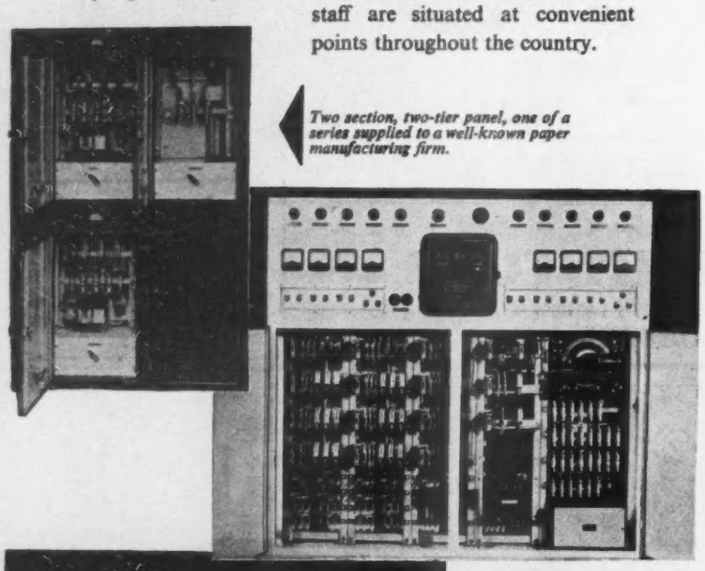

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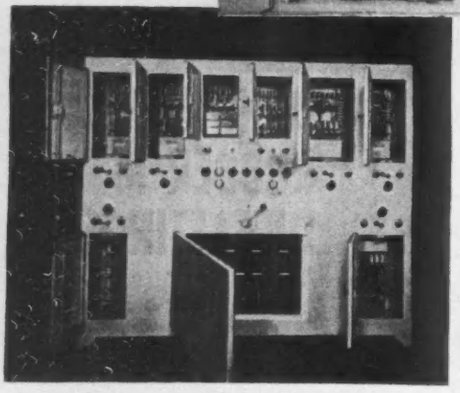

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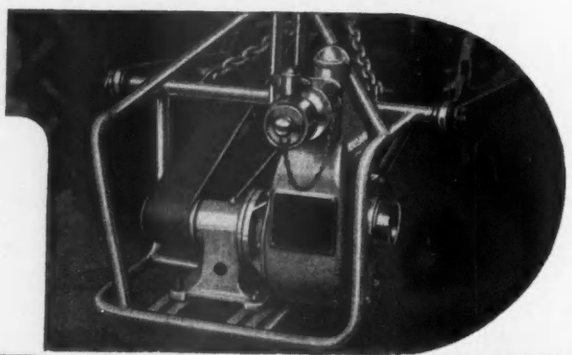

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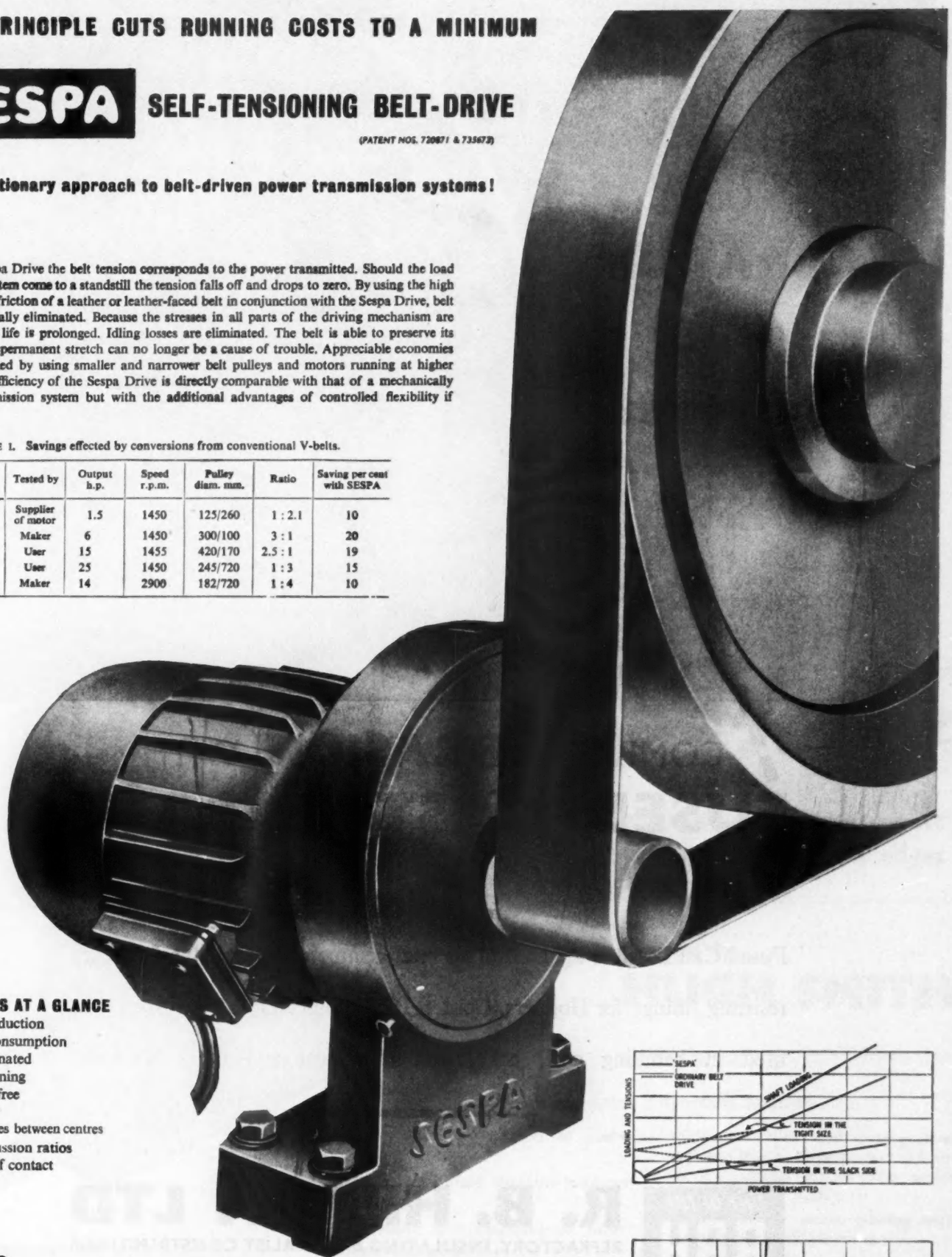
TABLE I. Savings effected by conversions from conventional V-belts.

Conditions Application	Tested by	Output h.p.	Speed r.p.m.	Pulley diam. mm.	Ratio	Saving per cent with SESPA
Loom	Supplier of motor	1.5	1450	125/260	1 : 2.1	10
Hammermill	Maker	6	1450	300/100	3 : 1	20
Fan	User	15	1455	420/170	2.5 : 1	19
Fan	User	25	1450	245/720	1 : 3	15
Compressor	Maker	14	2900	182/720	1 : 4	10



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Smoother running
Maintenance free
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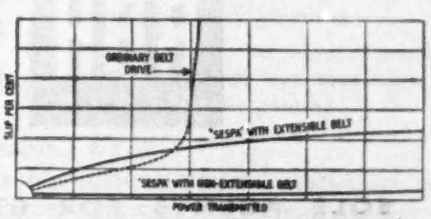
Shorter distances between centres
Larger transmission ratios
Small angles of contact



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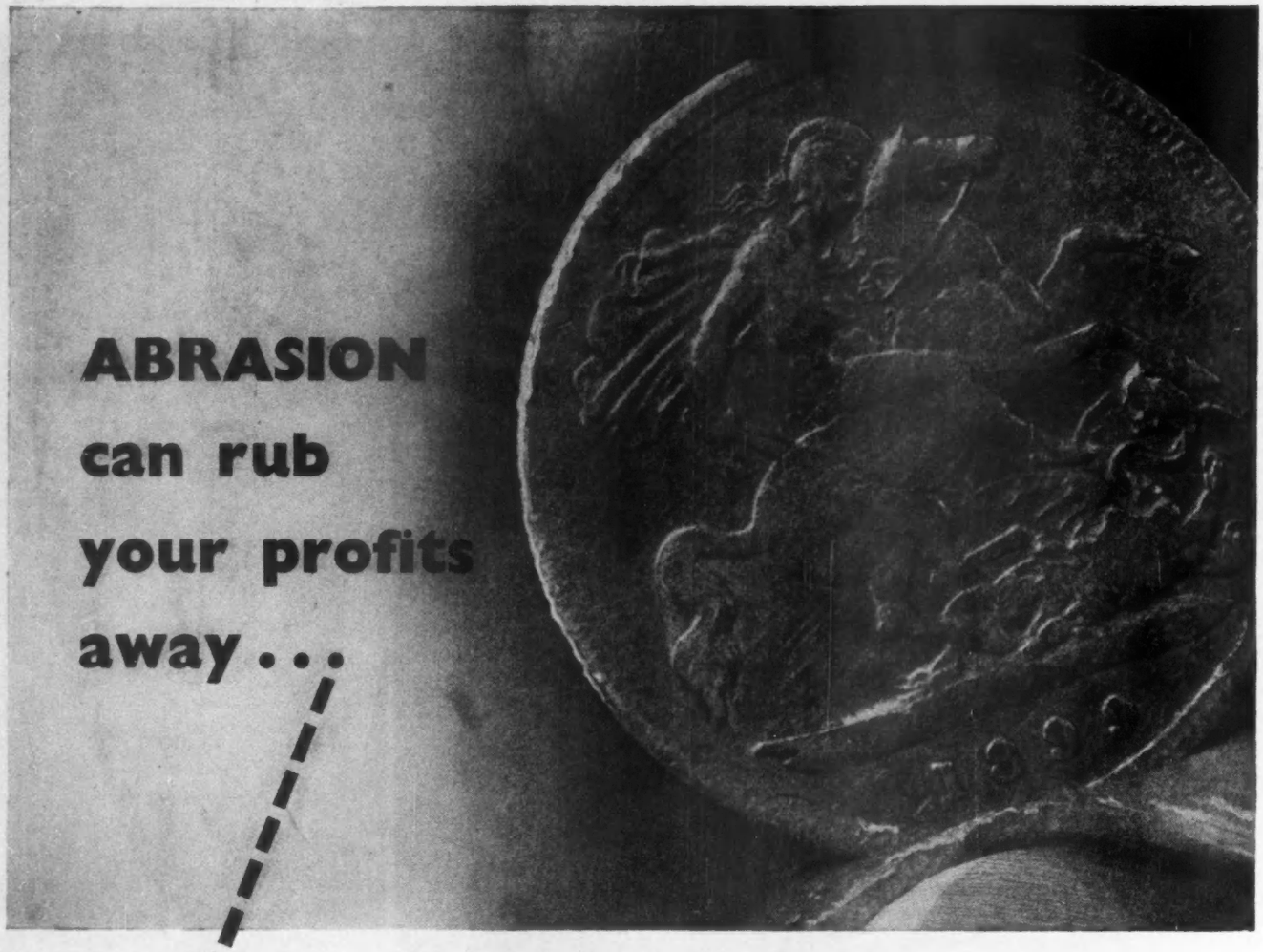

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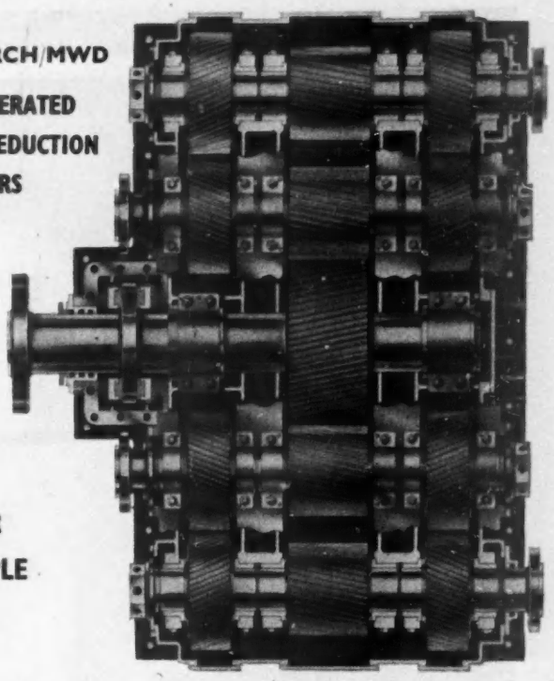

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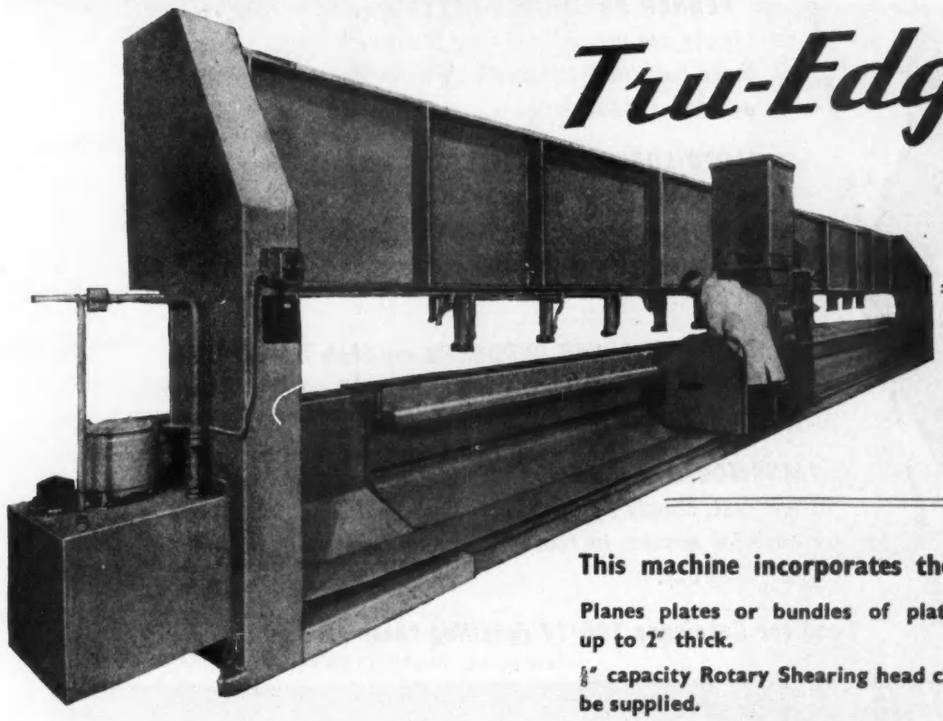

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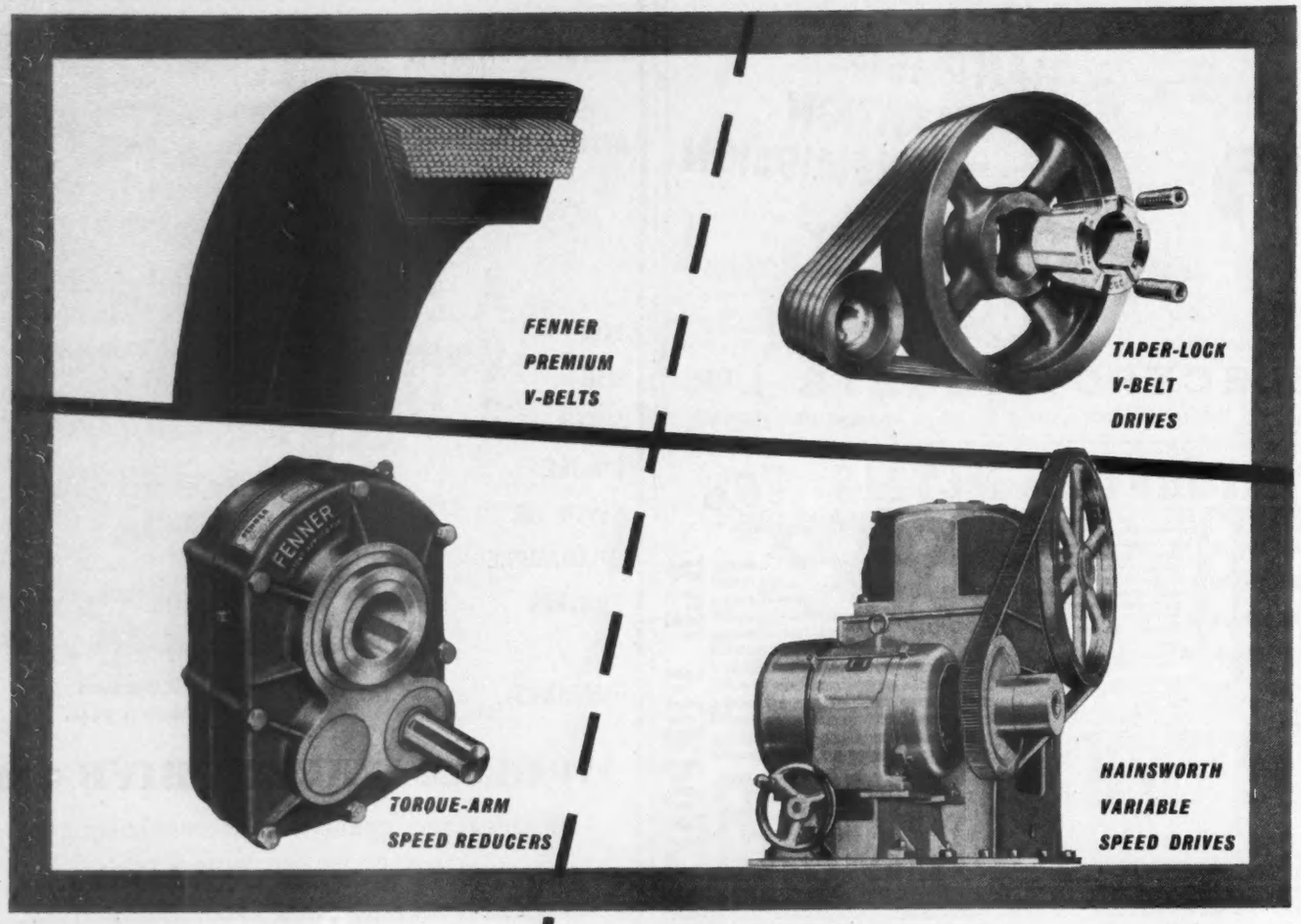

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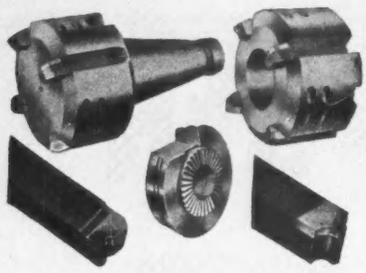

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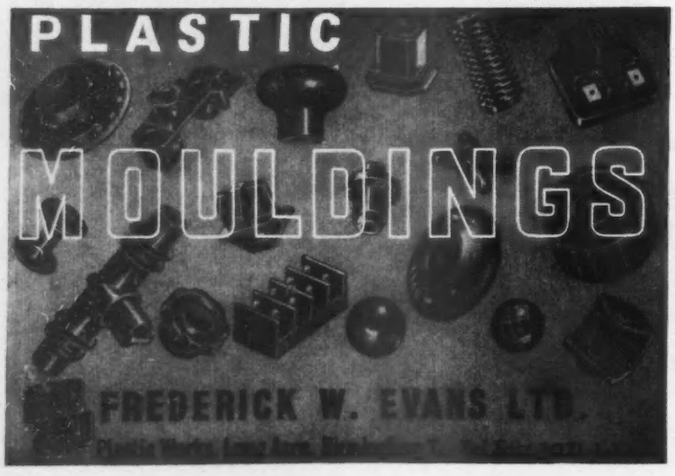

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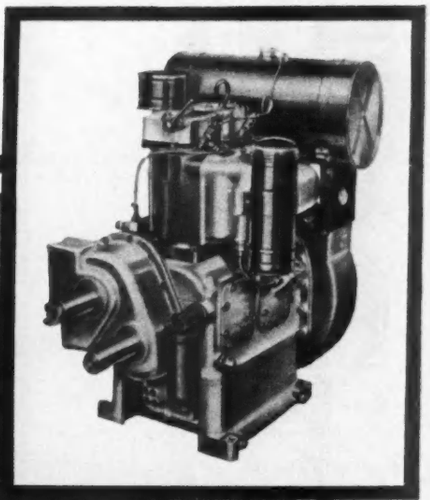

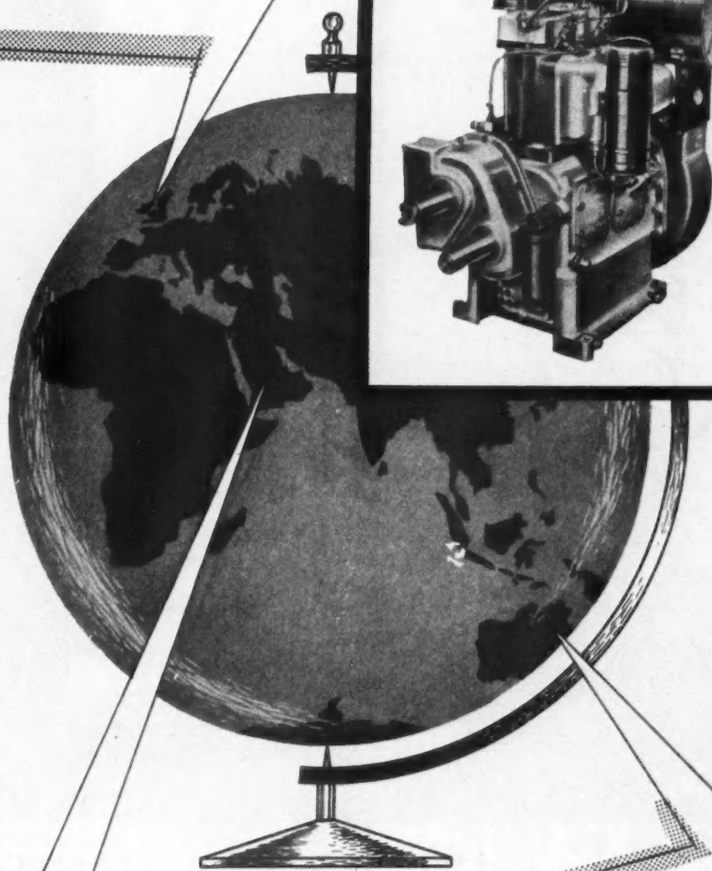

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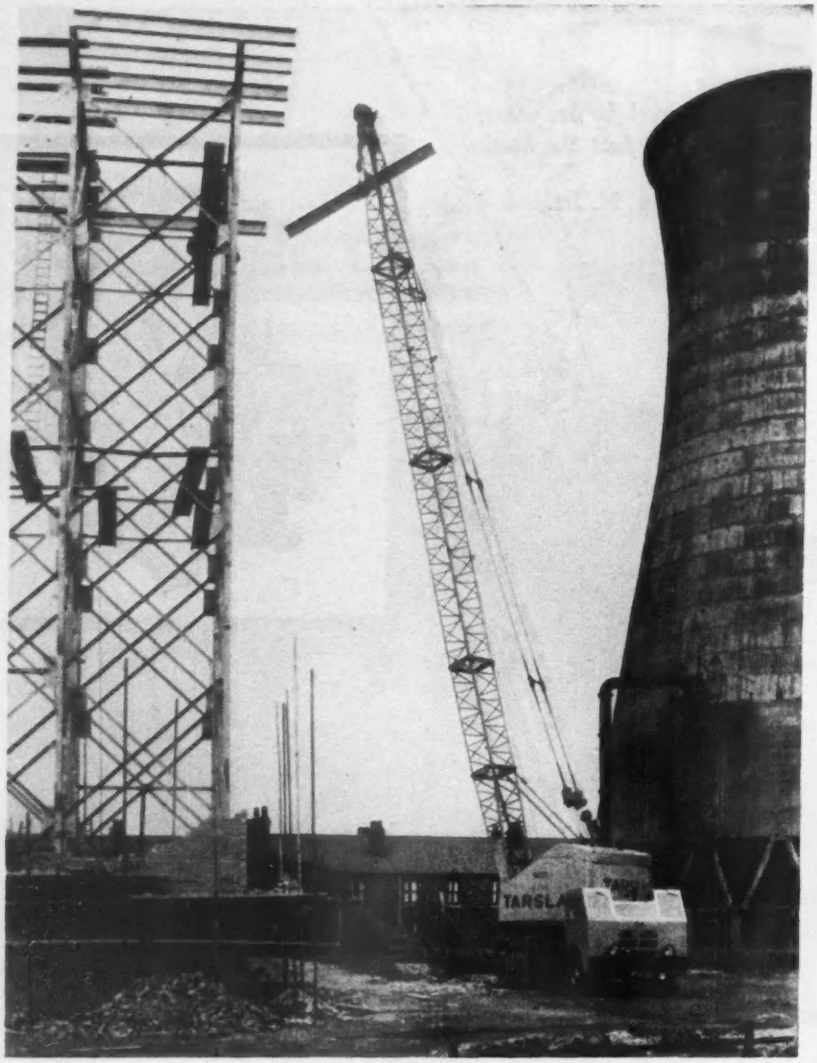

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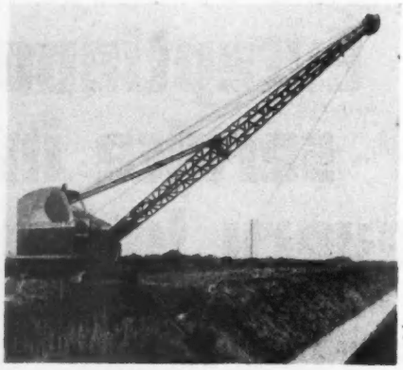
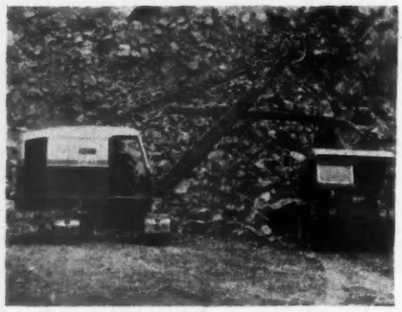


10-RB ¾ cu. yd. dragline dyke cleaning in the Fens



30-RB 1 cu. yd. shovel loading rock in a road stone quarry

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Consideration of the Ruston-Bucyrus range of excavators, particularly in the universal group of ⅜ to **1** cubic yard capacity, will suggest a ready solution to your excavating problems. The four machines in this category : **10-RB ¾ cu.yd., 19-RB ⅝ cu.yd., 22-RB ¾ cu.yd.** and the new **30-RB 1 cu.yd.** with air control, are ready and waiting to be applied to that new contract where their ability to do *more work* quicker and *at less cost* will increase your profit margin.

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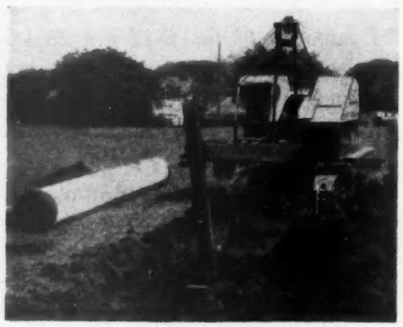

19-RB ⅝ cu. yd. dragshovel excavating pipe trenches for a water supply

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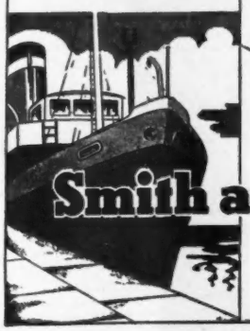

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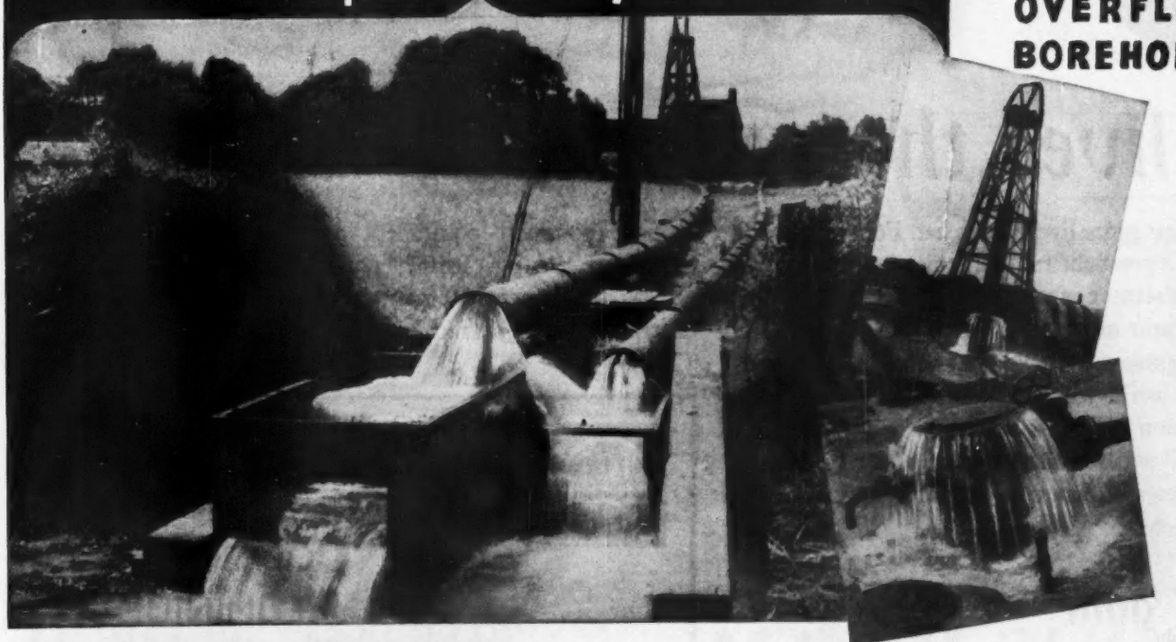

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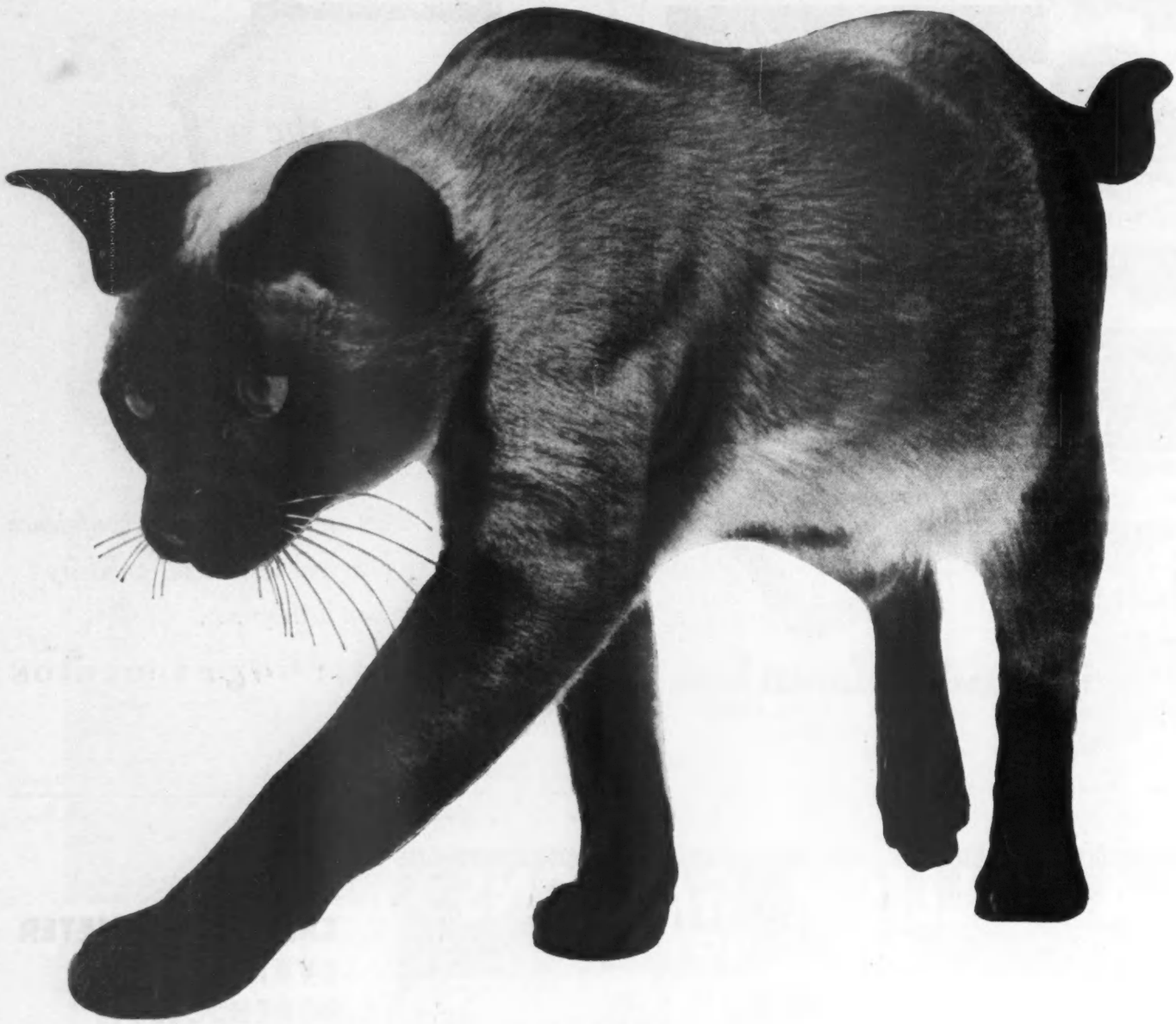

More lives than nine

I.C.I., it may seem, has more lives than a cat. For who would otherwise credit that a great chemical organisation should also be the leading manufacturer of non-ferrous metals?

Yet it came about quite naturally. Even in 1926, when I.C.I. was formed, the organisation included metal producers of long experience and world-wide reputation.

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What does the customer gain from this? Two things. First, he knows that, through I.C.I. Metals Division, he has at his service the finest equipment and the broadest practical experience in the British non-ferrous industry. Second, he has the benefit of that vigorous spirit of enquiry and enterprise which characterises the I.C.I. organisation.

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CAT 2

MOLYBDENUM DISULPHIDE ADDITIVE EXTENDS EFFECTIVE LUBRICATION

Molybdenum Disulphide greases are now being employed by all sections of British industry to overcome serious lubrication problems associated with extreme pressures, fretting corrosion, impact shocks, and arduous working conditions where oscillation and reciprocation are involved. Their use results in substantial reduction of wear, much lower starting torque and greatly improved running. This is clearly demonstrated by analyzing the following test data where in all cases the addition of MoS_2 extended the effective lubrication of the base lubricant.

Four tests show how MoS_2 reduces wear

1. SHELL 4-BALL EXTREME PRESSURE TEST

(see illustration top right)—MoS_2 addition reduces wear more than 50% and increases load capacity by about 70% over base grease.

2. FALEX 2-HOUR WEAR TEST

The chart below shows how MoS_2 sustains lubrication, as proved by a reduction of 500 per cent in average wear.

Grease	Loss in Weight of Specimen
Lithium-base	1,000 mg.
Lithium-base plus 2%MoS_2*	1·98 mg-average of 3 runs

3. TIMKEN ENDURANCE TEST

(see illustration bottom right)—MoS_2* sustains lubrication well beyond the capabilities of the base grease alone, and at a lower temperature than conventional E.P. grease.

4. SIMULATED SHACKLE BOLT SERVICE TEST

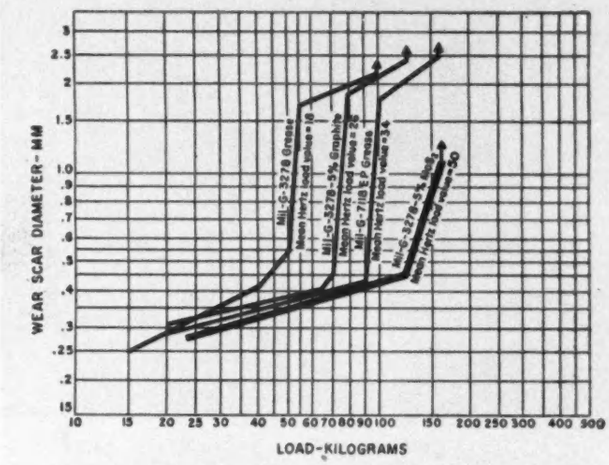
Oscillating friction machine—3%MoS_2* addition virtually doubles the effective lubrication of a lithium base chassis grease—is far more effective than conventional additions.

Hours to failure—average of 2 tests

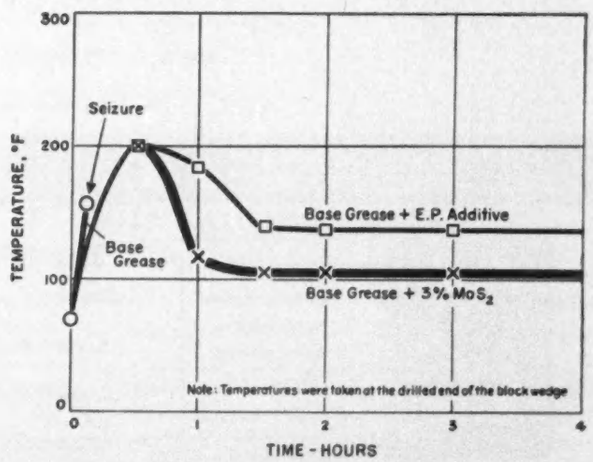
Additive	None	3%MoS_2*	5%ZnO	15%ZnO
Dry	350	564	336	555
Wet	162	264	109	85

* Fine particle size.

Molybdenum Disulphide greases are manufactured in the U.K. by a number of specialist producers, whose names can be obtained, together with a copy of "MOLY-Sulfide as a Grease Additive", from :—


WEAR SCAR DIAMETER - MM
LOAD - KILOGRAMS
Mil-G-3278 Grease
Mean Hertz load value = 10
Mil-G-3278-5% Graphite
Mean Hertz load value = 26
Mil-G-7118 E.P. Grease
Mean Hertz load value = 34
Mil-G-3278-5% MoS2
Mean Hertz load value = 50

4-ball E.P. test shows the superior extreme pressure properties of MoS_2 grease over the same grease without additives. In the same test, grease containing 5% graphite had a mean Hertz load value of 26: the conventional E.P. grease Hertz value was 34.


TEMPERATURE, °F
TIME - HOURS
Seizure
Base Grease
Base Grease + E.P. Additive
Base Grease + 3% MoS2
Note: Temperatures were taken at the drilled end of the block wedge

Timken endurance test clearly shows how MoS_2 functions when added to a base grease. With base grease alone, the specimen seized in about 10 minutes. With MoS_2 added, lubrication was effectively sustained throughout the test at a reduced temperature of about 100°, compared with a temperature of about 130° for the conventional E.P. grease.

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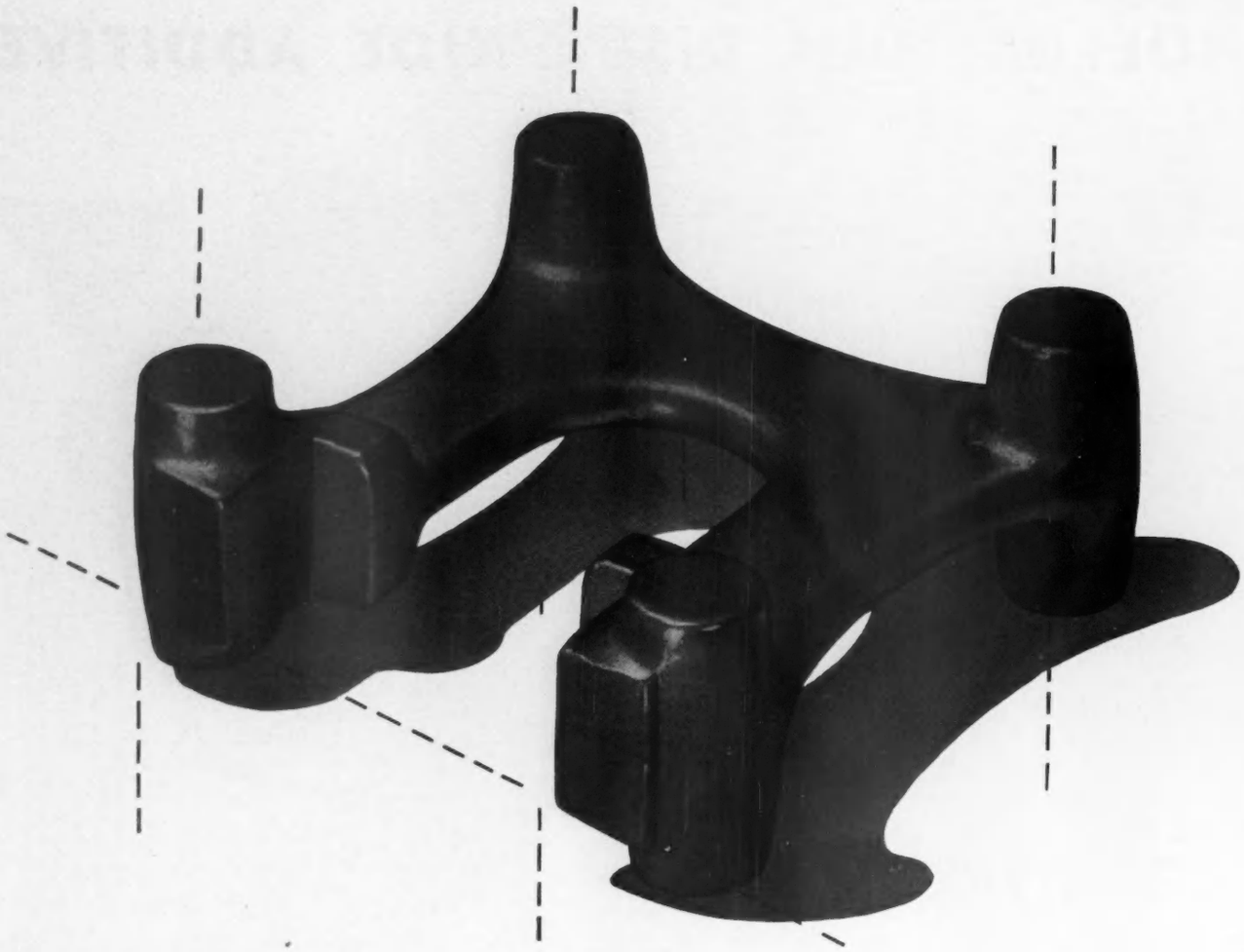
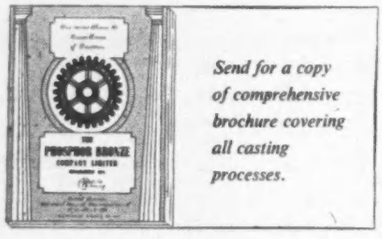
† *MOLY-Sulfide is a Climax brand name*



Shaw Process or Lost Wax?



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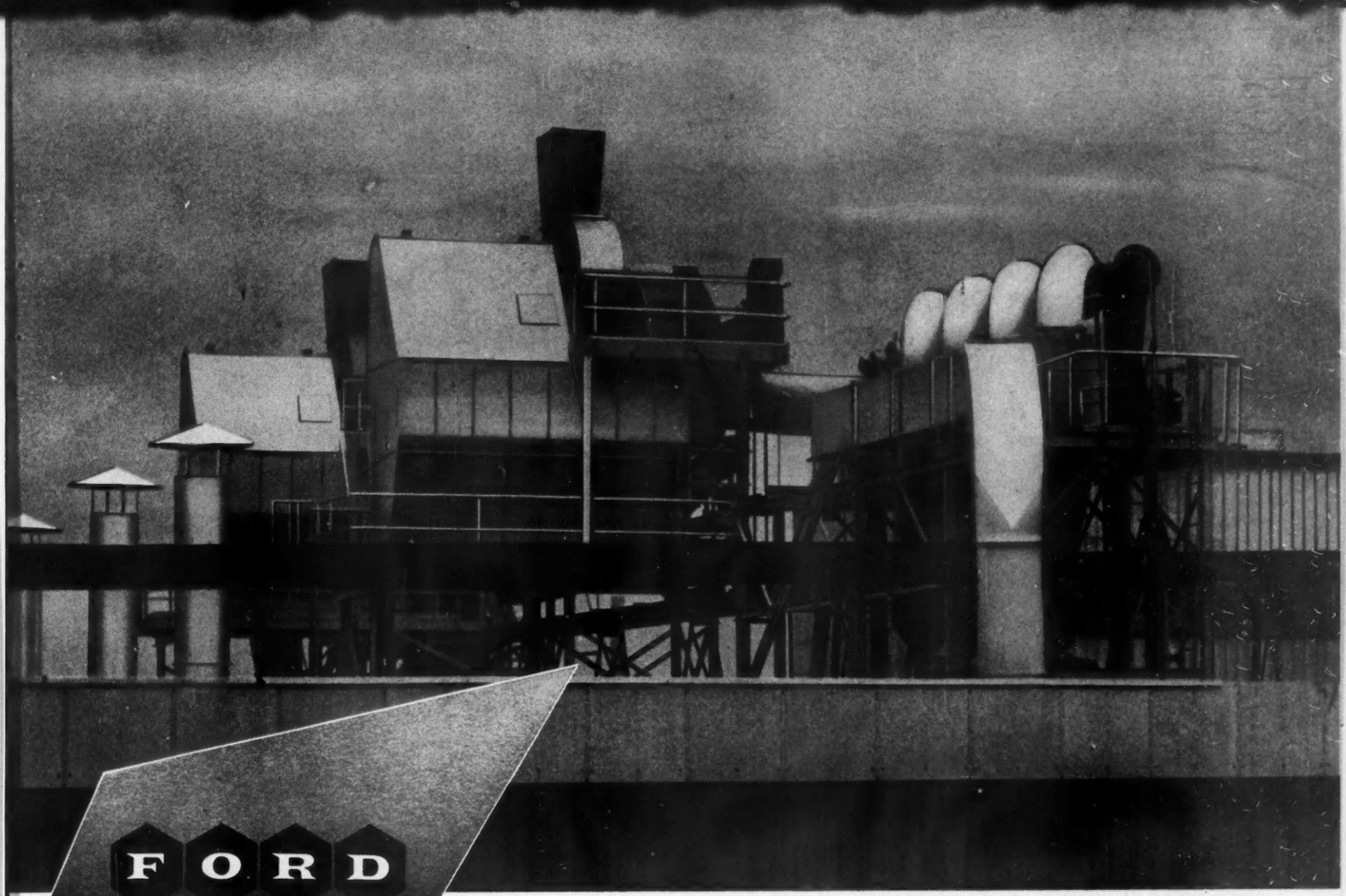

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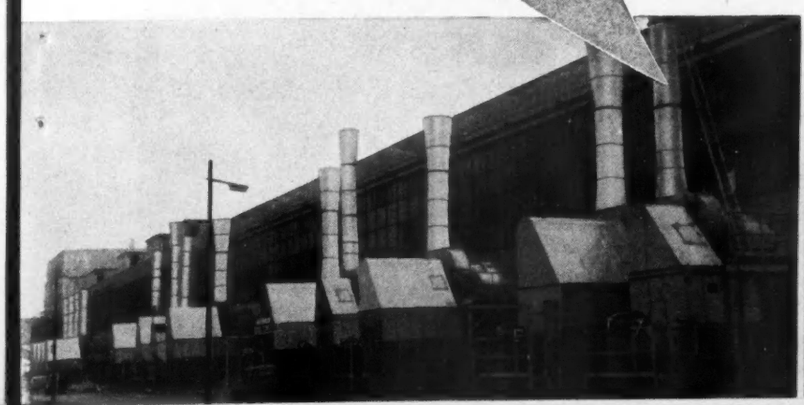

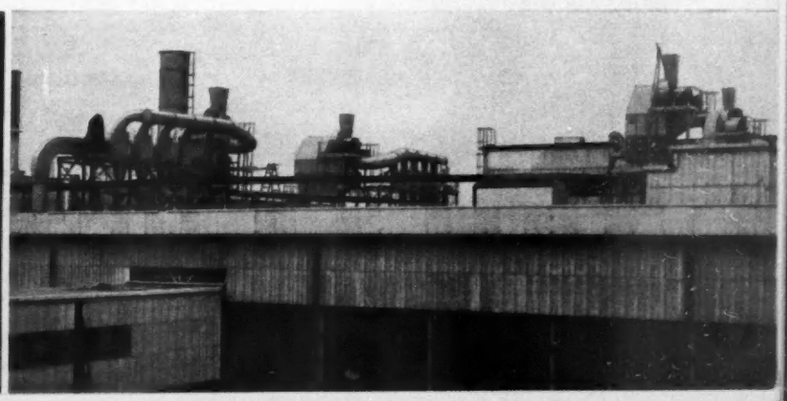

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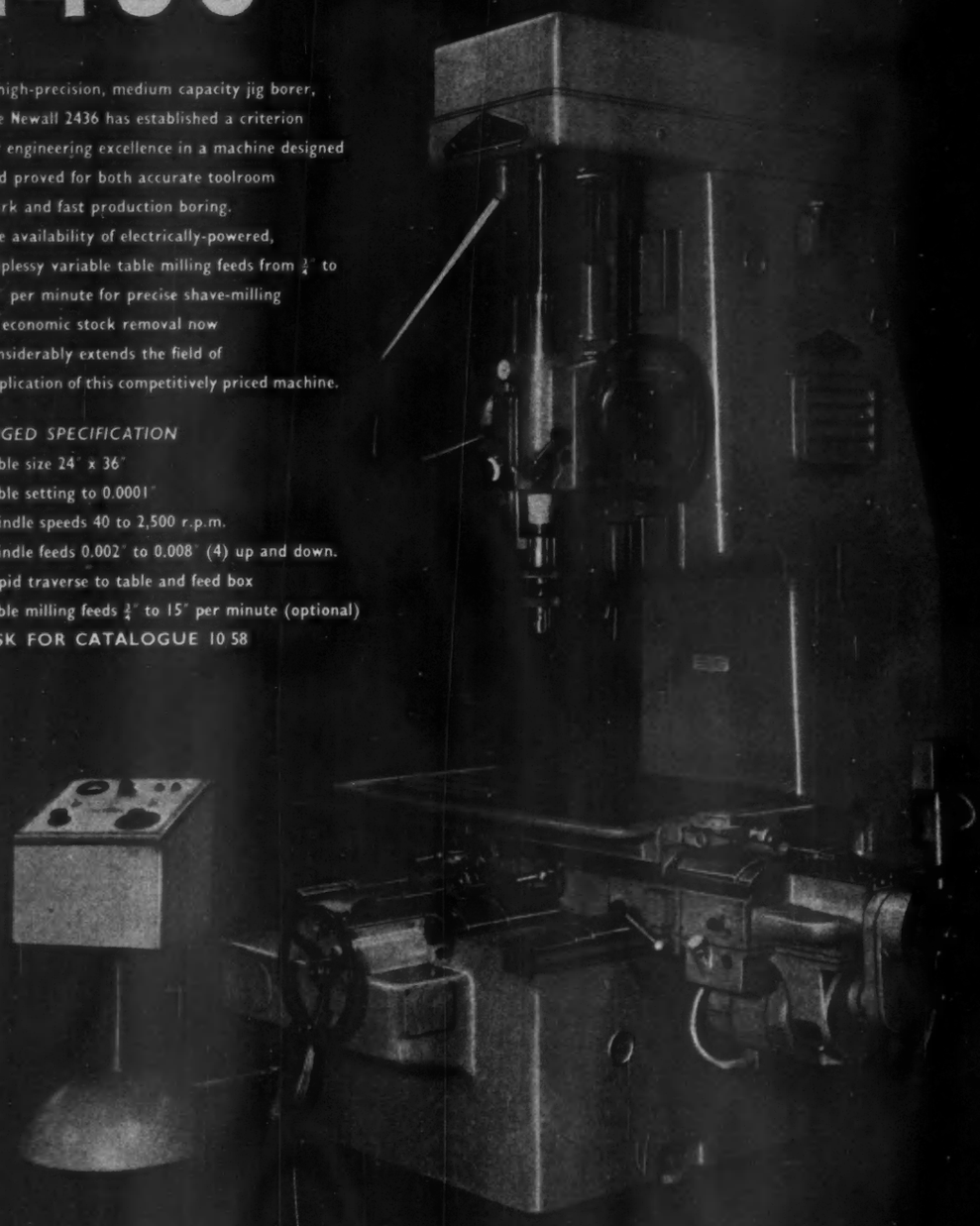

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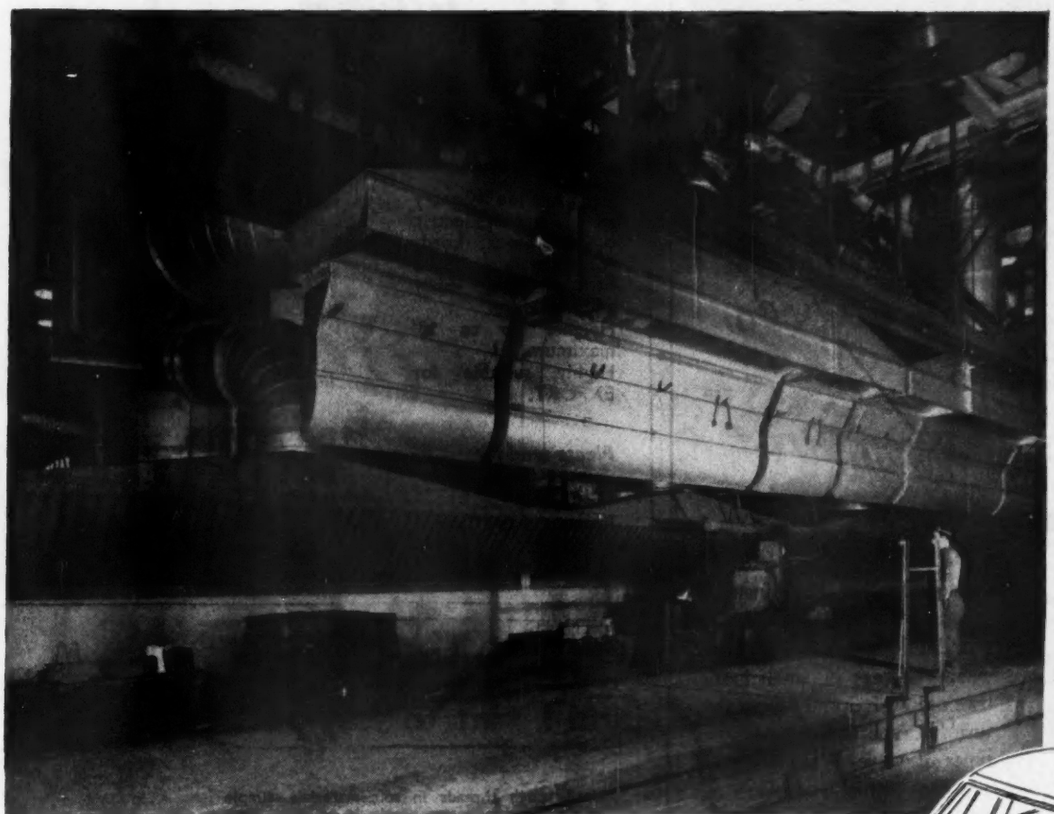

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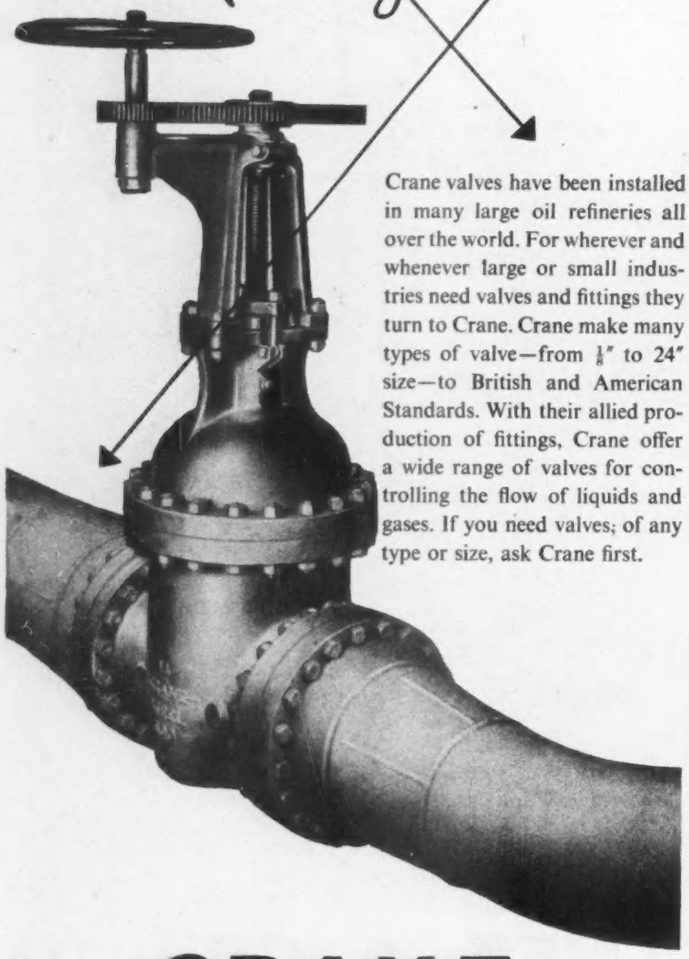

Crane valves have been installed in many large oil refineries all over the world. For wherever and whenever large or small industries need valves and fittings they turn to Crane. Crane make many types of valve—from ⅛" to 24" size—to British and American Standards. With their allied production of fittings, Crane offer a wide range of valves for controlling the flow of liquids and gases. If you need valves of any type or size, ask Crane first.

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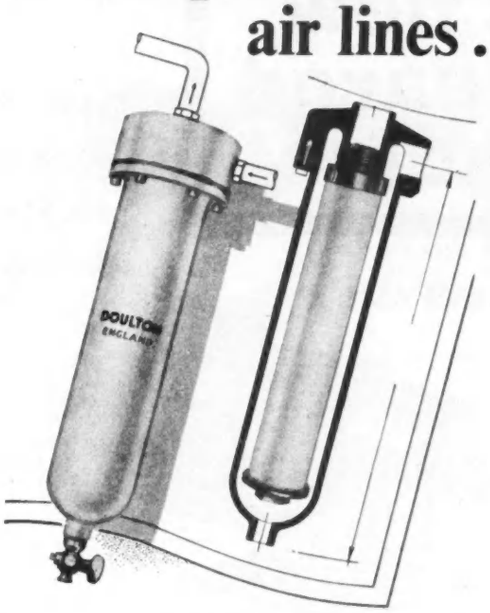

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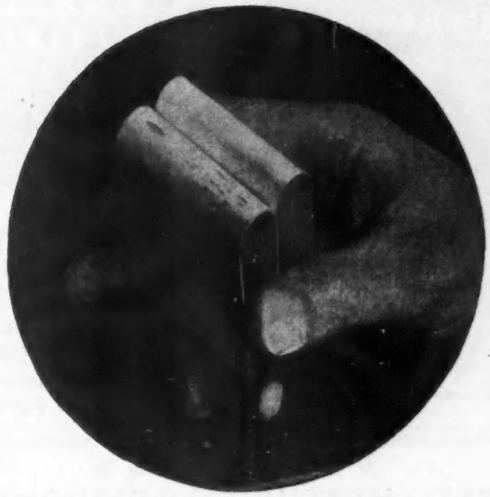

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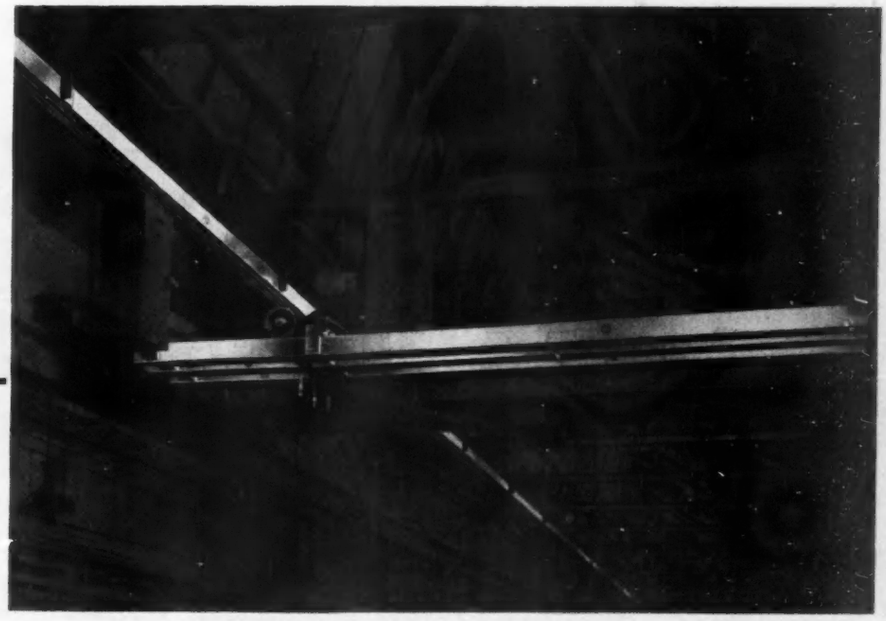

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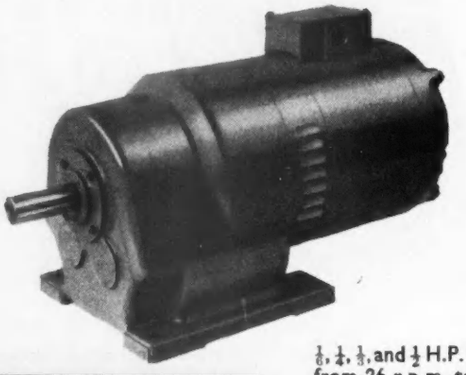

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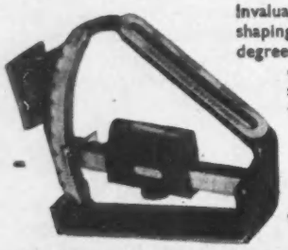

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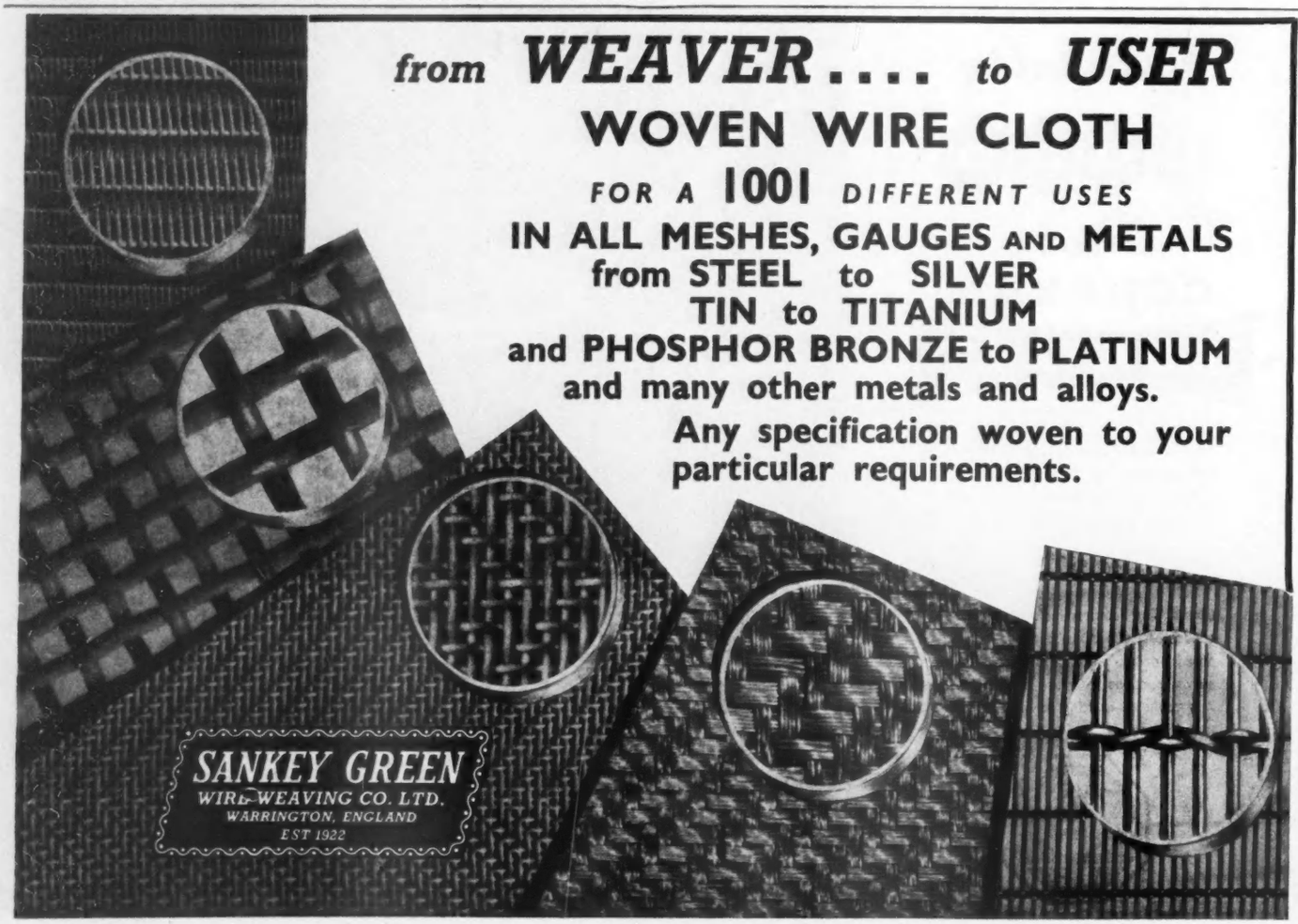
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two of the largest ever, serve the four 108 in. diameter cupolas. By improved combustion conditions a better quality iron is provided at the lowest cost. Our catalogue 'HOT BLAST CUPOLA PLANTS' describes the equipment in detail.

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Illustration shows ISIS drawing table fitted with ISIS drafting machine.

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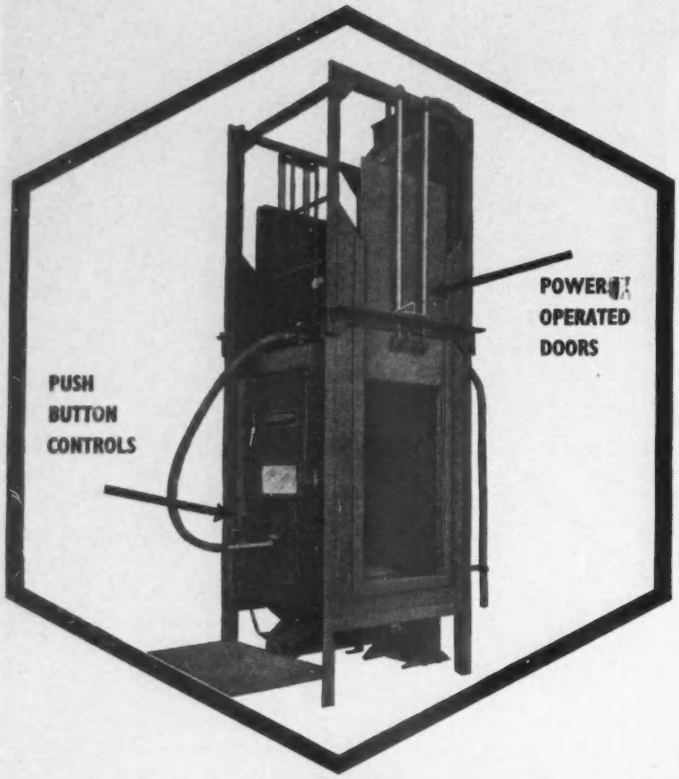

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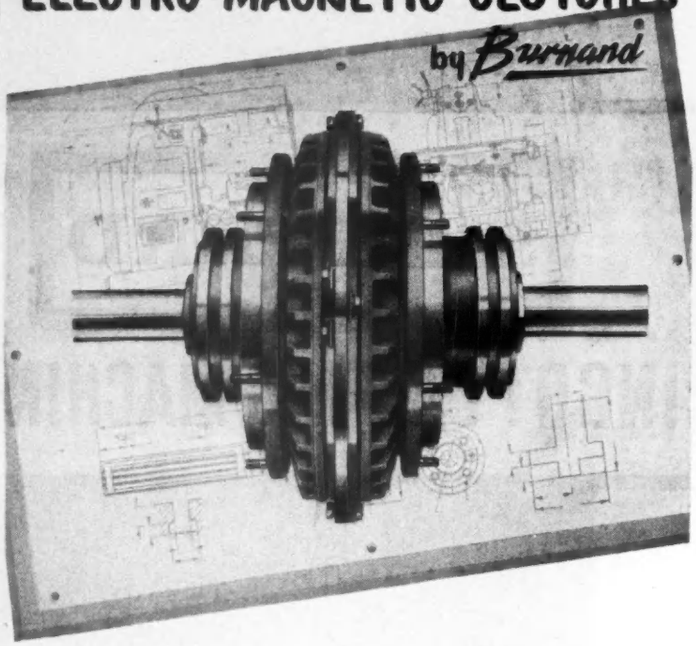

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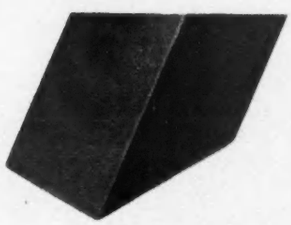

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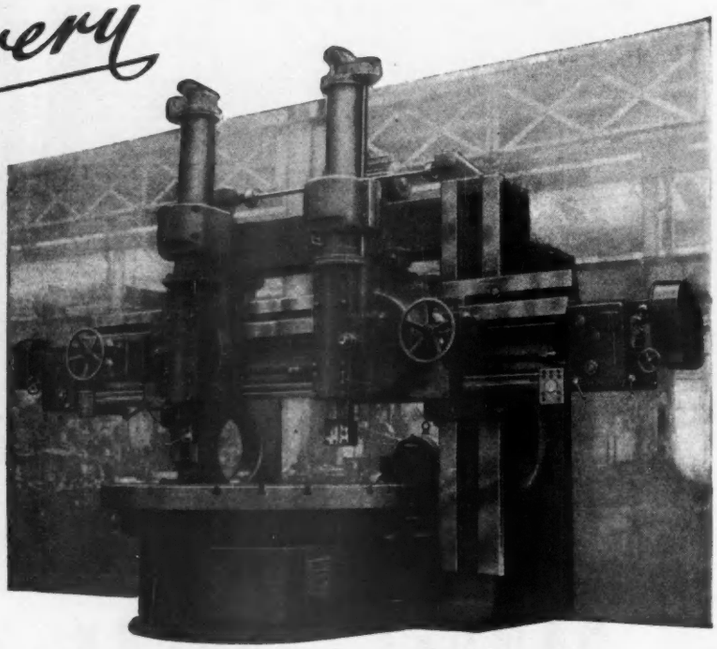

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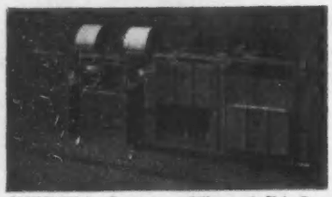

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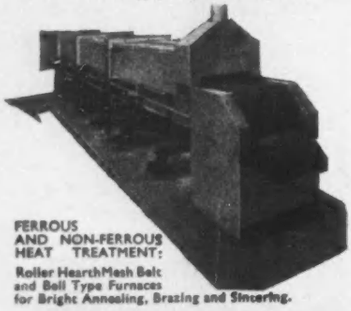

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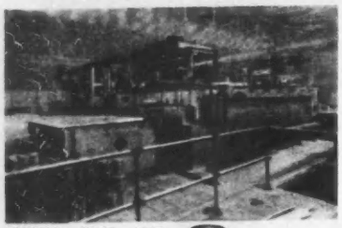

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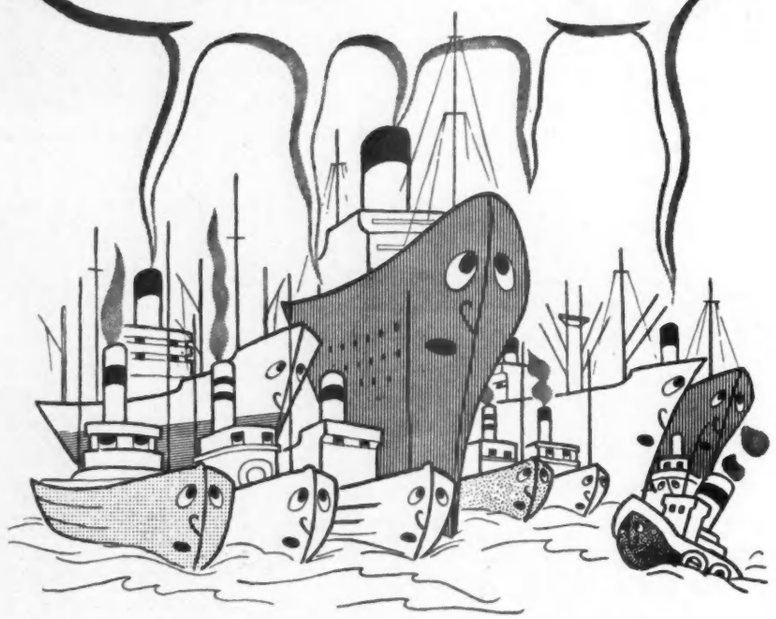

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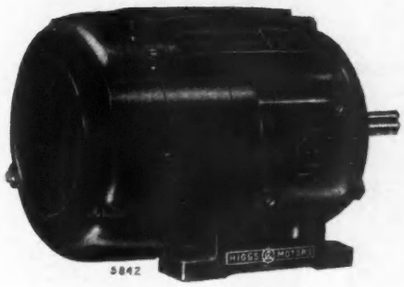

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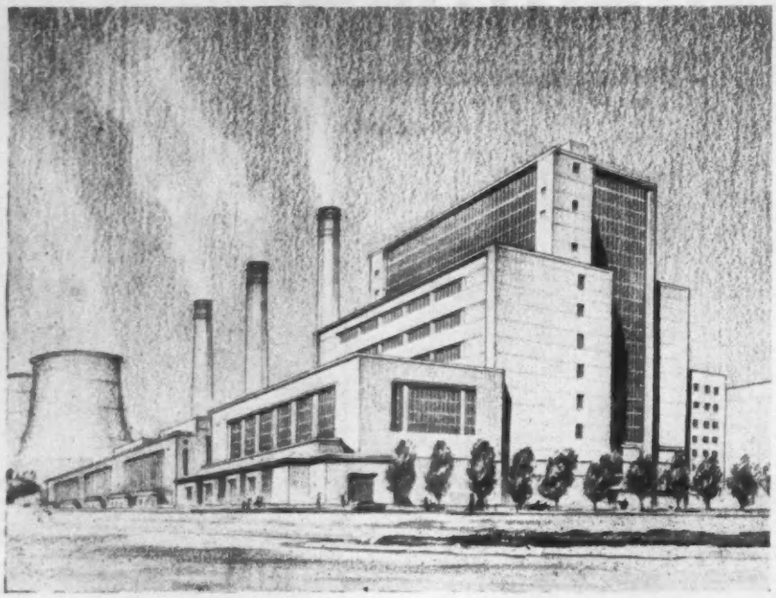
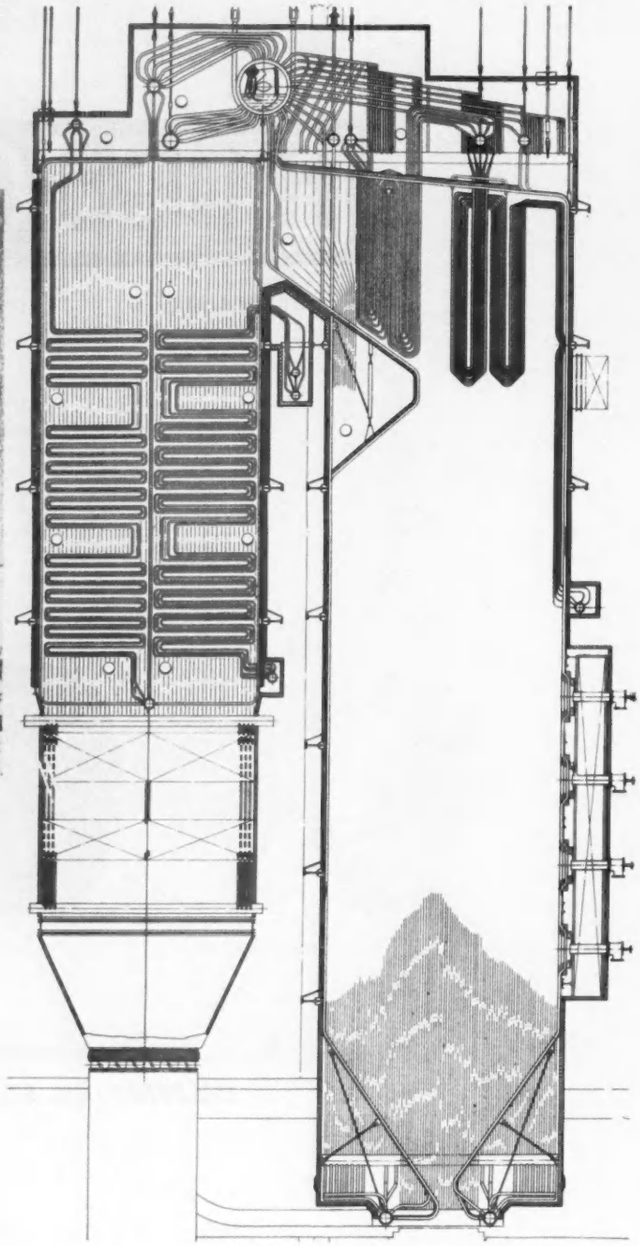


Artist's impression of Staythorpe Power Station.



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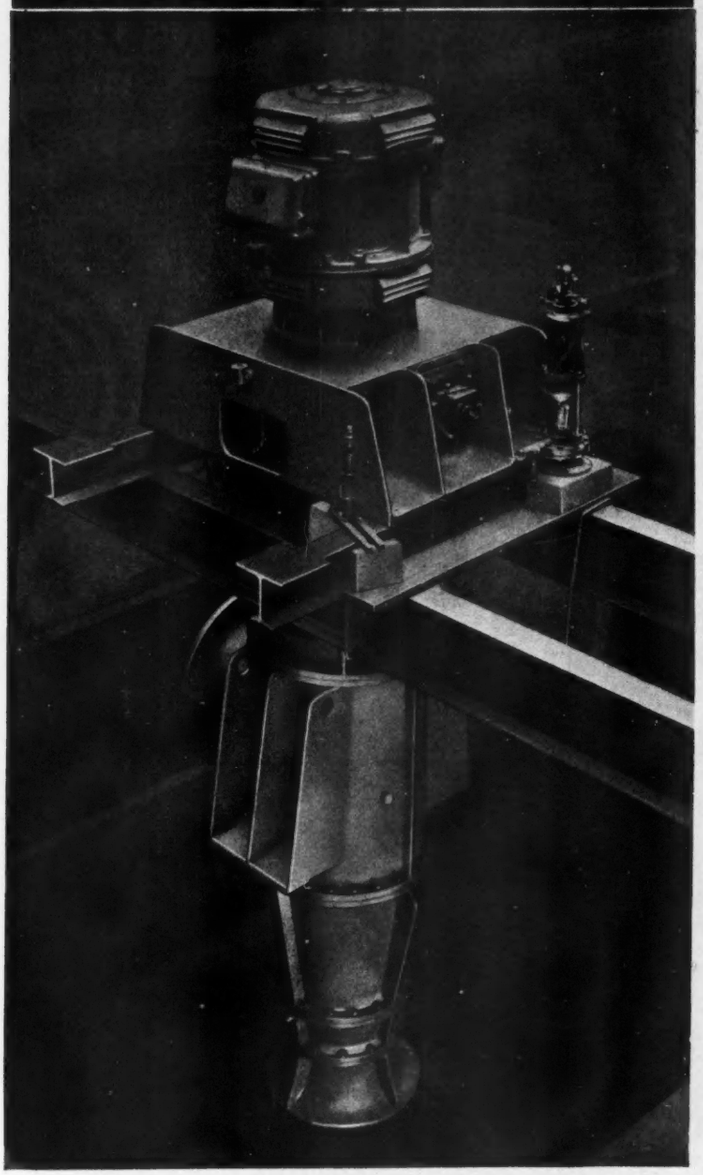

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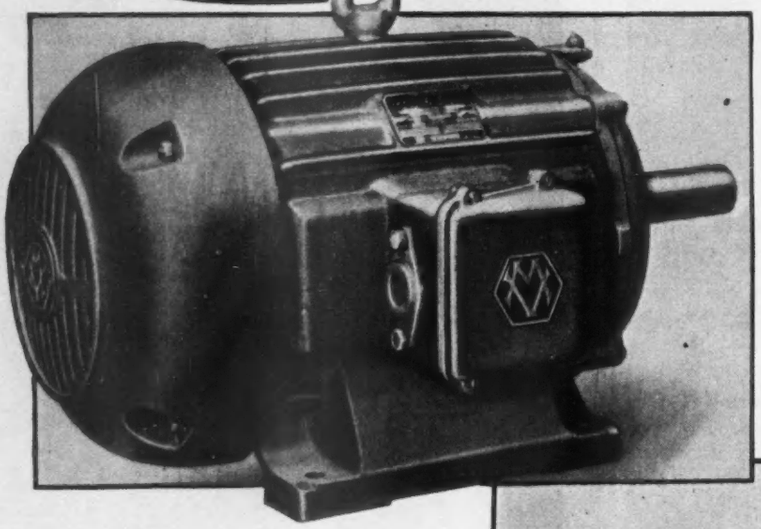
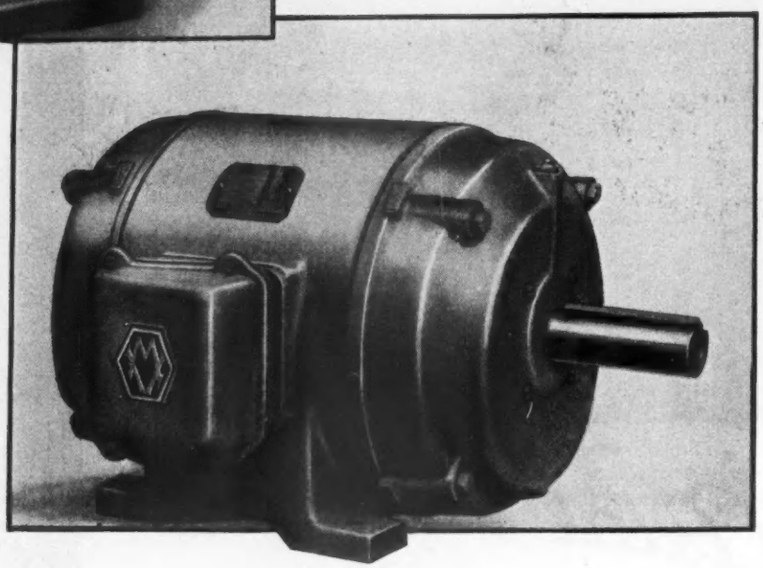


Type KN-B to BS2083/1956
TEFC ENCLOSURE
1-20 hp* (4-pole)

**Additional Ratings not included in BS2083 are also available up to 50 hp.*

With the introduction of the new BS2960/1958, squirrel-cage motors with Standardised Dimensions can now be supplied with VENTILATED as well as TEFC enclosures. Metrovick Motors designed and built to these specifications are known as Types KN-C and KN-B respectively.



Type KN-C to BS2960/1958
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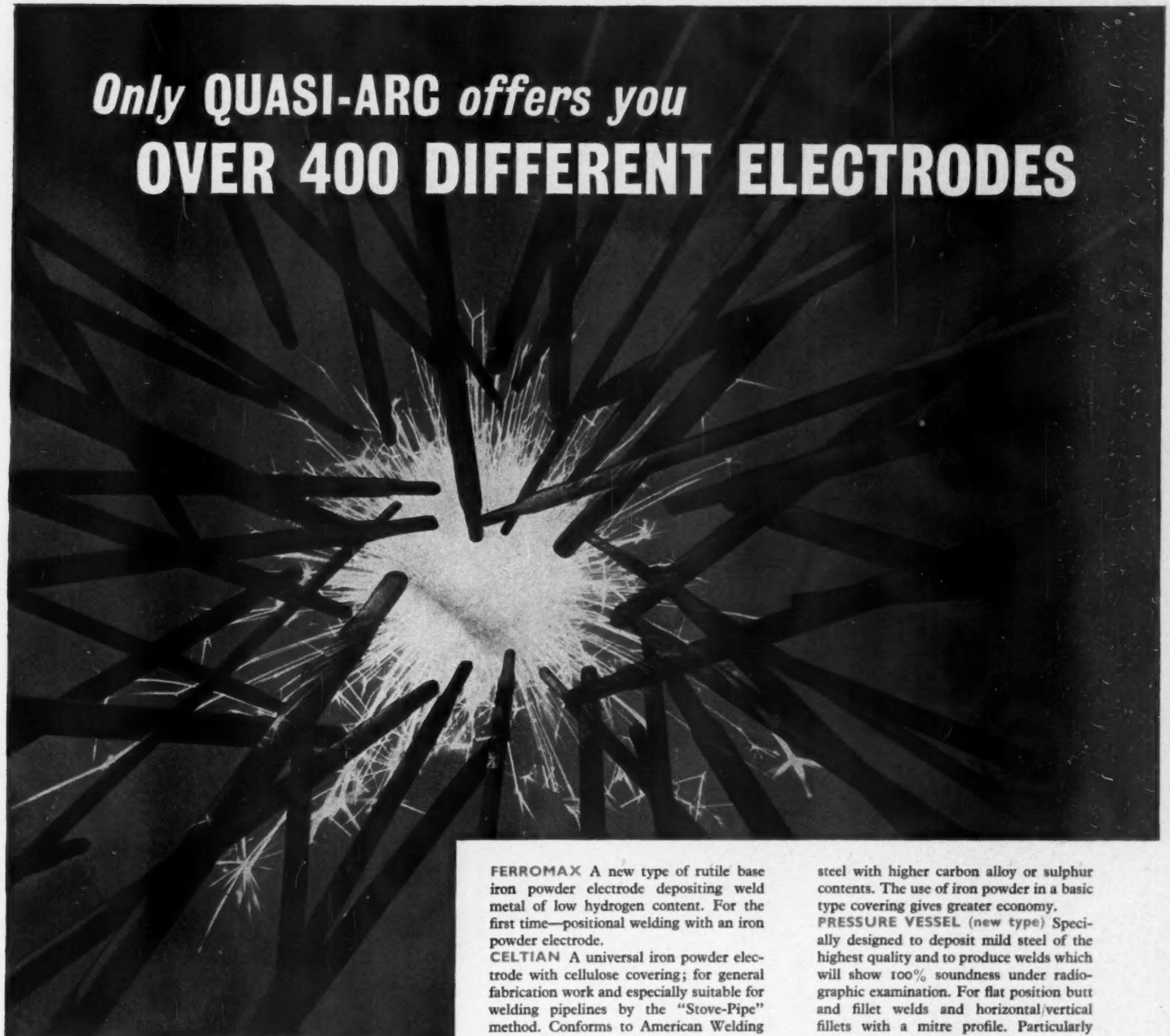

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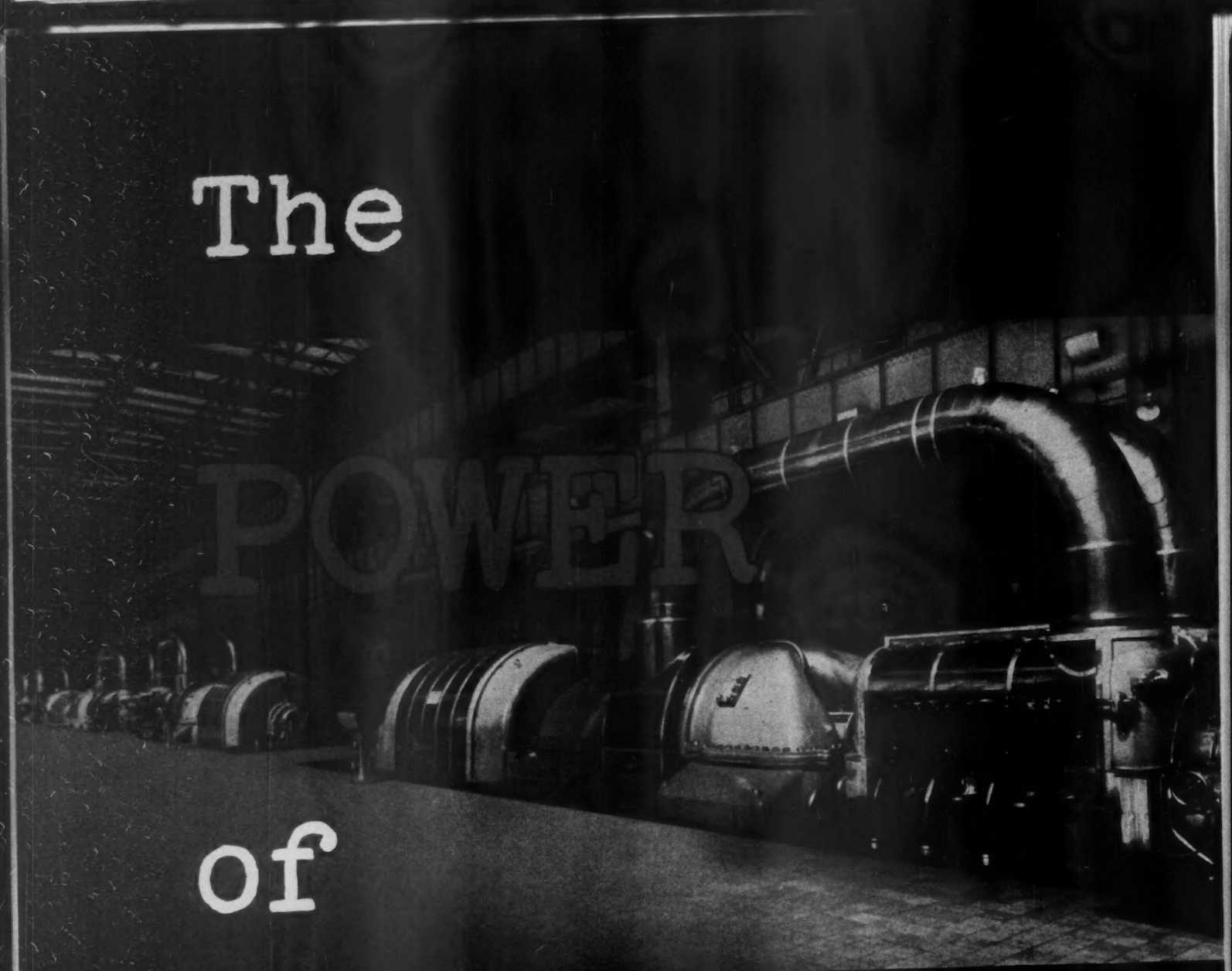

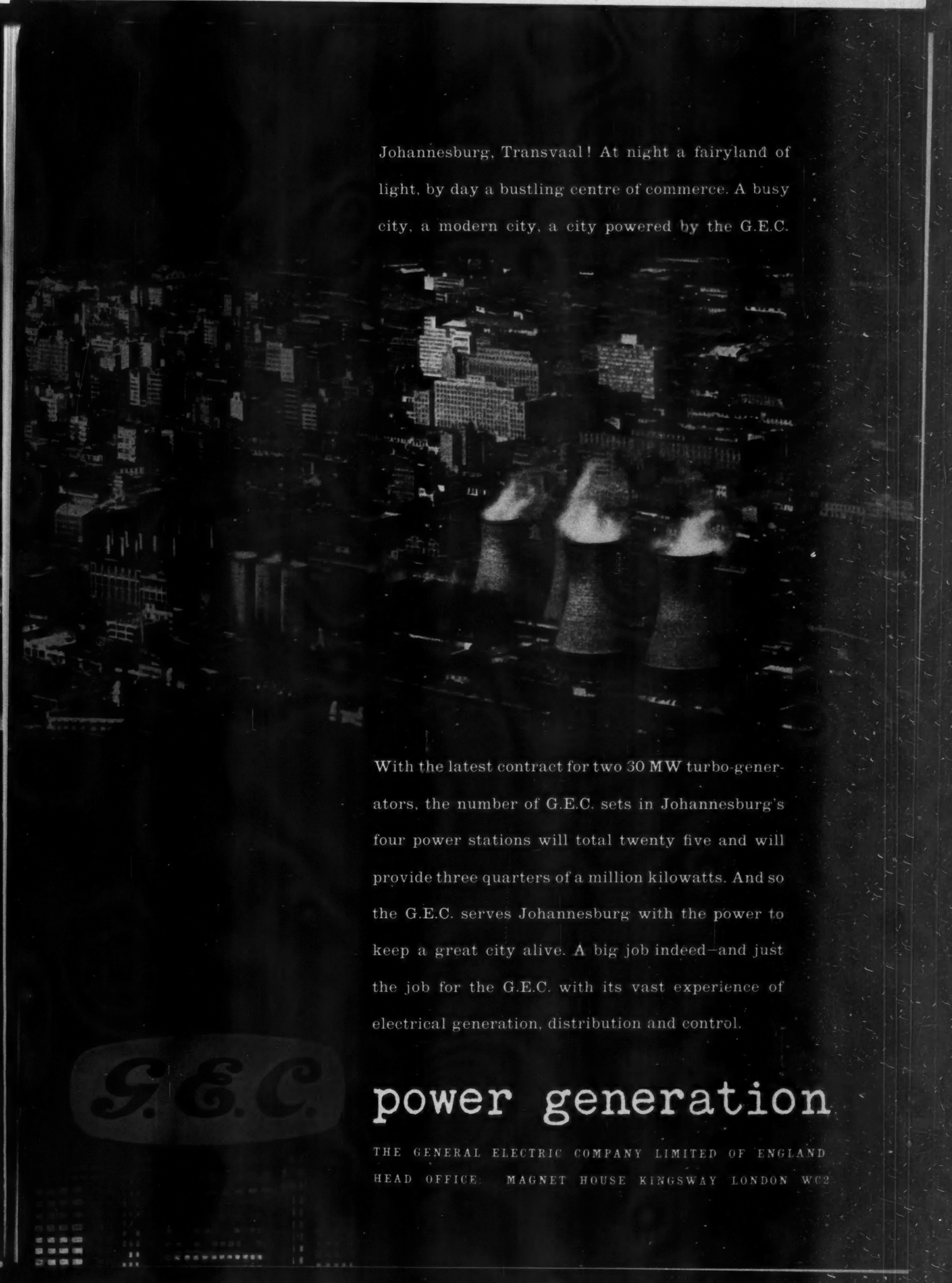

Johannesburg, Transvaal! At night a fairyland of light, by day a bustling centre of commerce. A busy city, a modern city, a city powered by the G.E.C.

With the latest contract for two 30 MW turbo-generators, the number of G.E.C. sets in Johannesburg's four power stations will total twenty five and will provide three quarters of a million kilowatts. And so the G.E.C. serves Johannesburg with the power to keep a great city alive. A big job indeed—and just the job for the G.E.C. with its vast experience of electrical generation, distribution and control.

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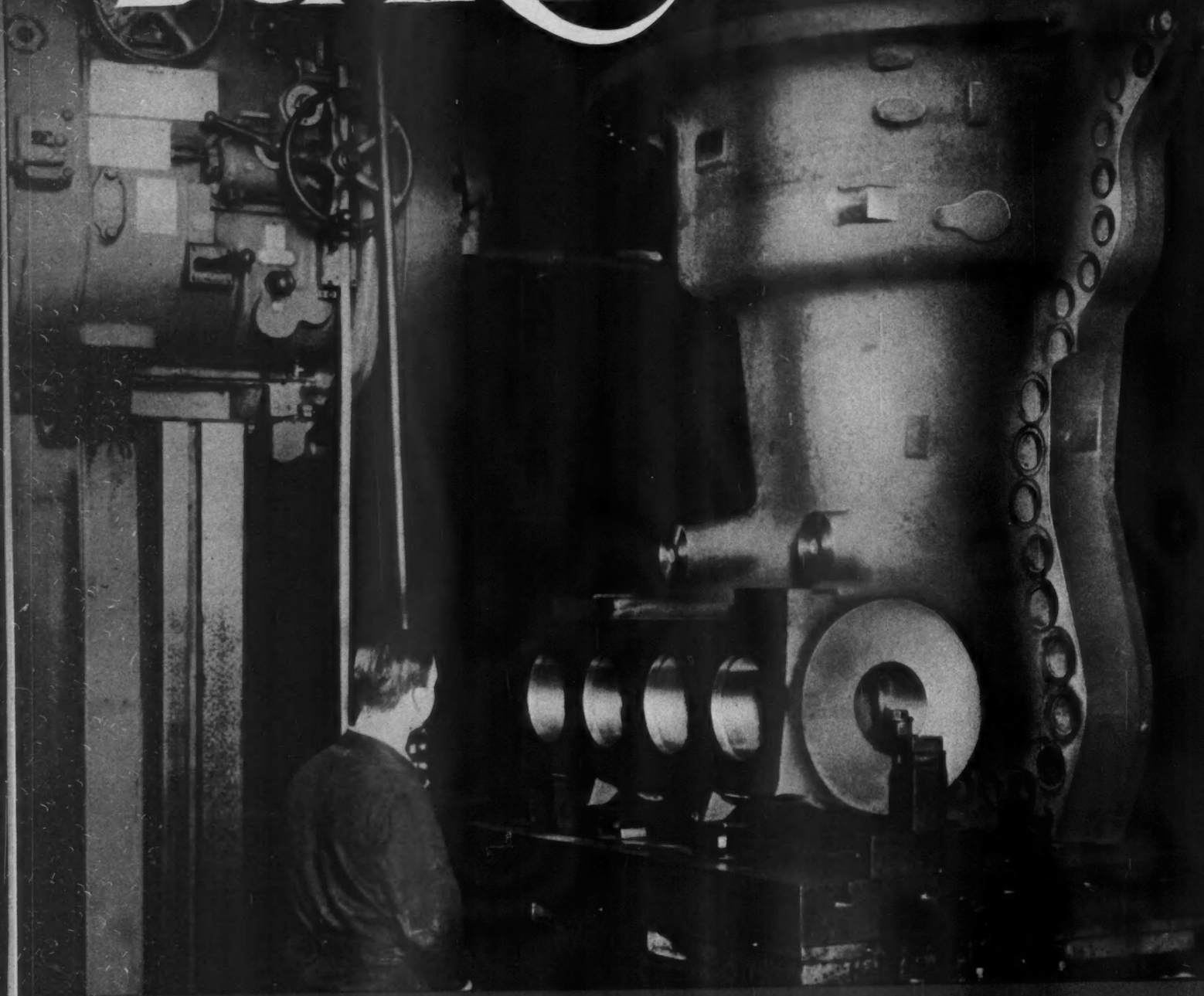

Illustration: Beardmore casing for 90 MW steam turbine H.P. cylinder half-casing, in the Trafford Park works of Metropolitan-Vickers Electrical Company Limited.

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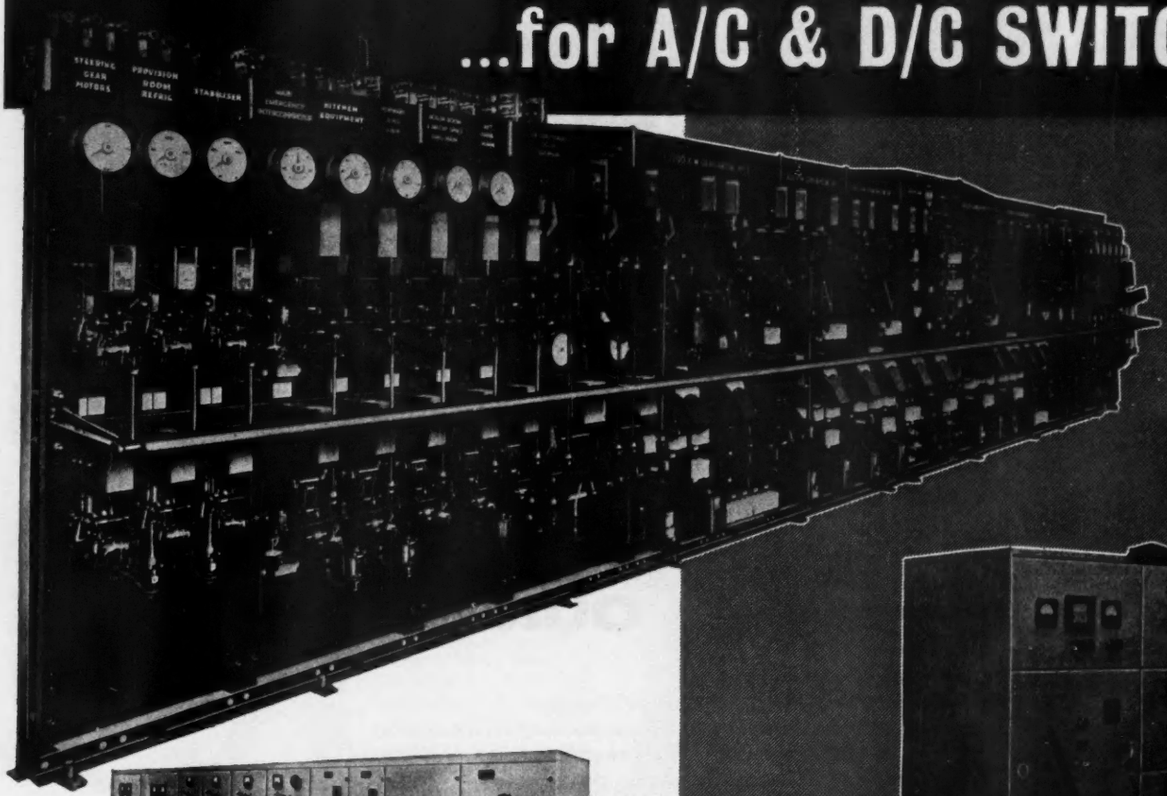
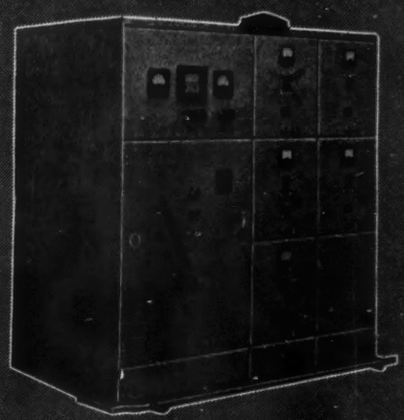
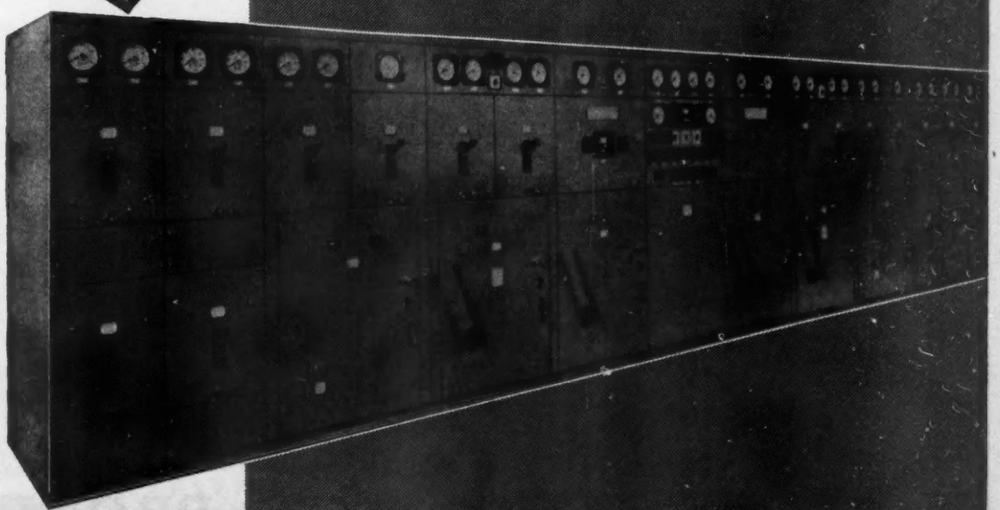


A typical example of an OPEN TYPE D/C SWITCHBOARD as supplied for Steel Works and marine installations.



A fine example of an A/C BOARD constructed for a large steelworks in this country.

The above photograph shows in some detail an A/C INDUSTRIAL TYPE SWITCHBOARD supplied to a large tyre manufacturer.



A D/C CUBICLE TYPE SWITCHBOARD equipped with withdrawable D/C breakers, as supplied to Harbour Boards Steelworks and Atomic Power Stations.

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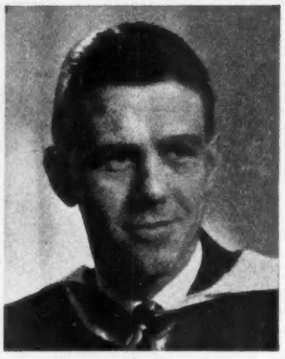

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B.Sc.(Eng.), A.M.I.Chem.E.

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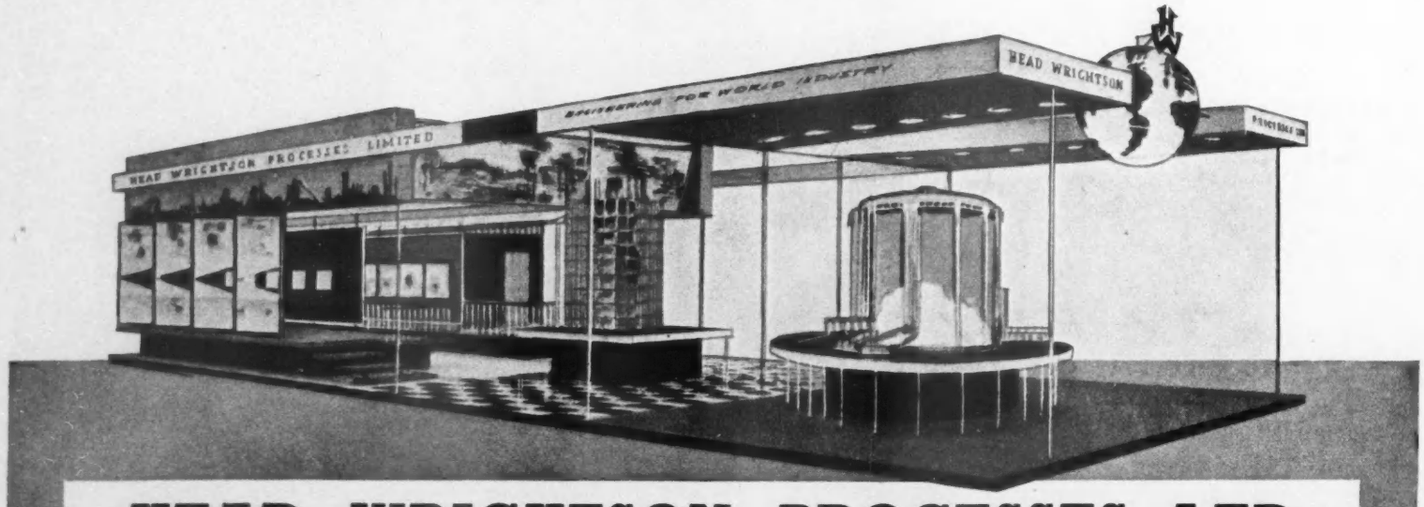

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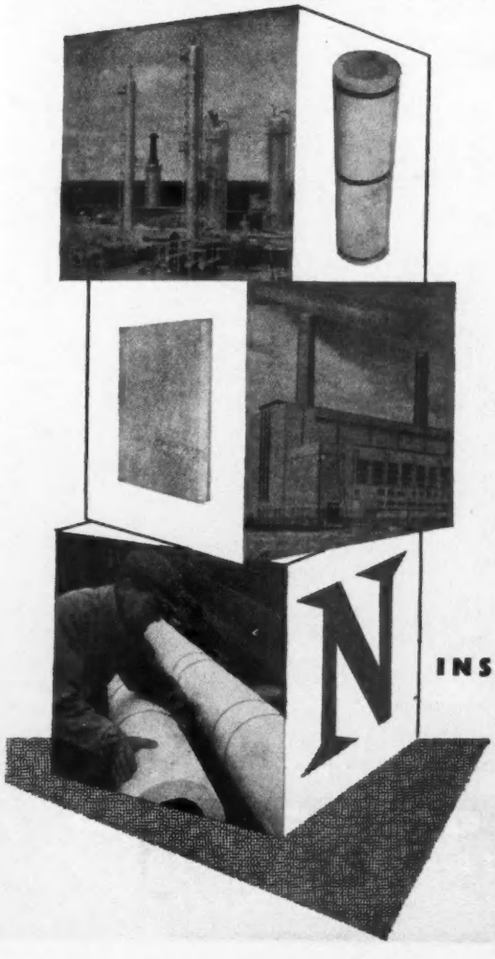

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IF you look through a list of insulation contracts completed in recent years by Newalls you will see that they relate to many of the most important industrial enterprises undertaken since the war. In such a list will appear power stations, oil refineries, chemical works, cold stores, as well as many other plants where effective thermal insulation has been put to profitable use. Nor are our products confined to this country. For example, some 600 tons of thermal insulation material was supplied by Newalls to the British Petroleum Company's refinery at Aden.

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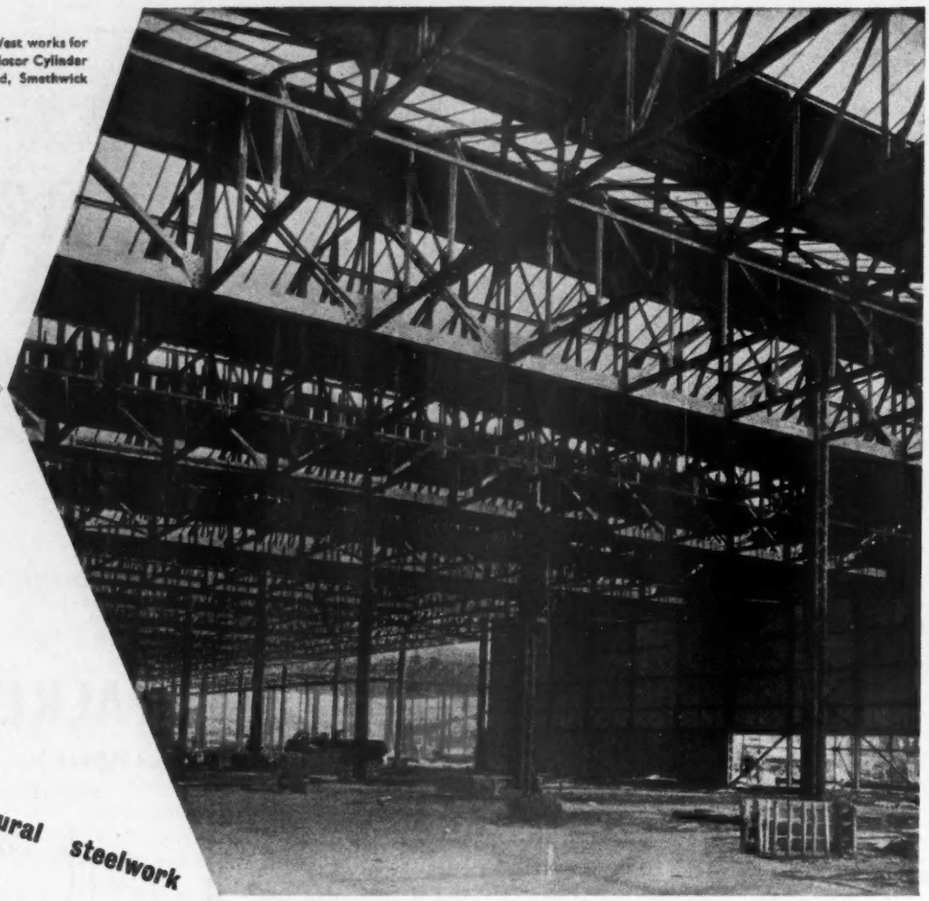

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(Patent pending)

gives a 3 in 1 sling

- **safer mechanical splice**
- **slimmer sleeve**
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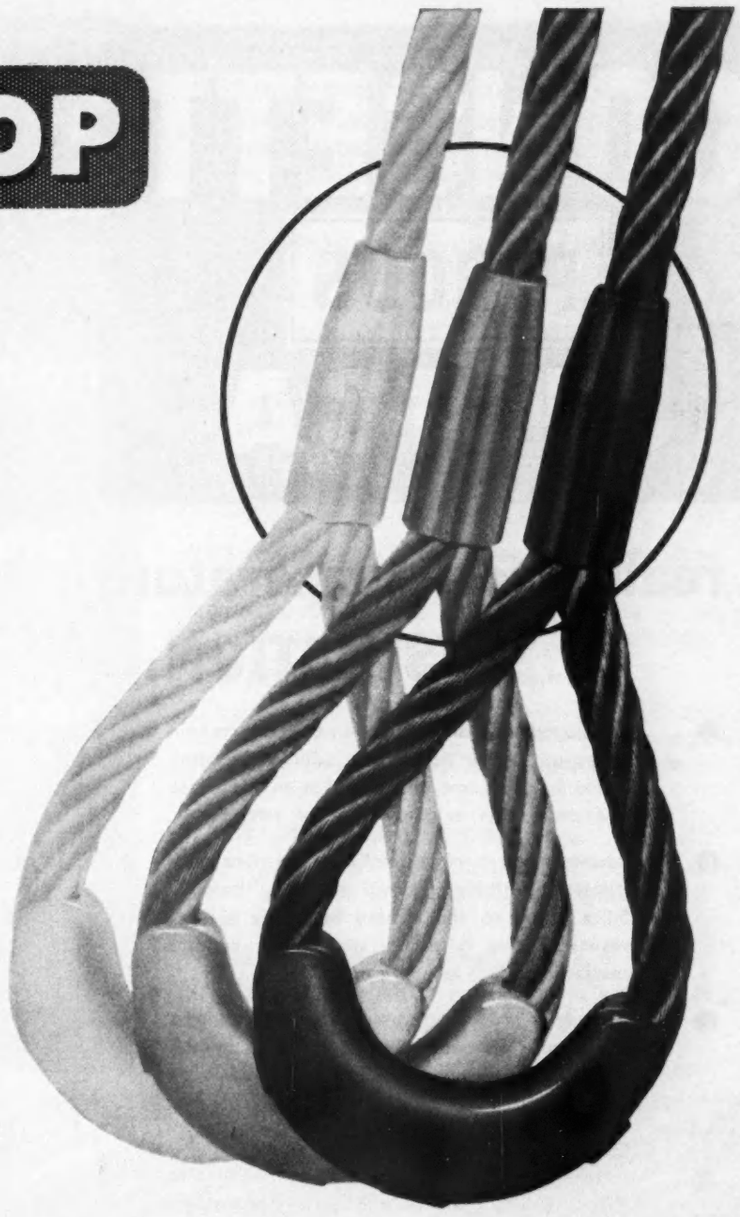

The three big advantages of British Ropes' new mechanical splice give you for the first time a safe, slim, easily handled splice with a true centre pull.

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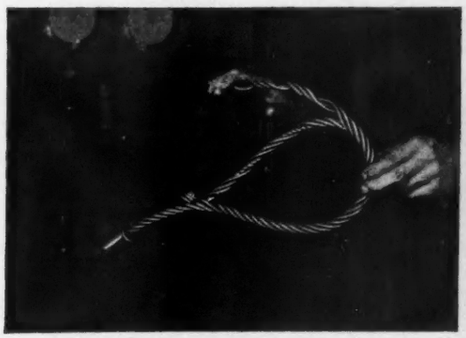
The construction of the Superloop is fully explained in our Brochure — If you are a user of slings — send for this book.

SUPERLOOP in conjunction with Blue Strand Preformed Rope gives you the perfect sling.

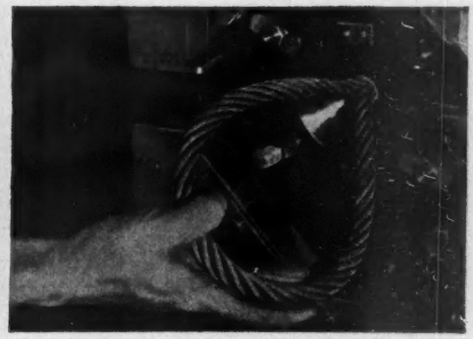


FORMING THE LOOP

The secret of SUPERLOOP's true centre pull — a Flemish Eye is hand spliced and this alone gives a strength in excess of the Safe Working Load even before *the sleeve is fitted.*

FITTING THE SLEEVE

The steel sleeve is fitted neatly over the tails of the splice and is tapped into place entirely covering the wire ends.



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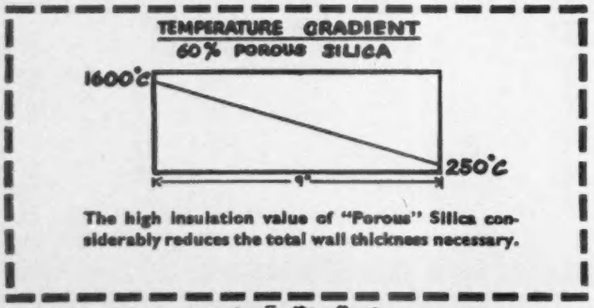
- Already in wide use in the glass industry for roof insulation, "Porous" Silica Brick is also suitable for the construction of kiln roofs and side walls where its light weight and insulating properties are important factors in design and service.
- "Porous" Silica Bricks are made in two grades, 60% and 50% porosity, the latter possessing a higher mechanical strength, rendering it the most suitable for constructional work.

Further information will be gladly supplied on request.



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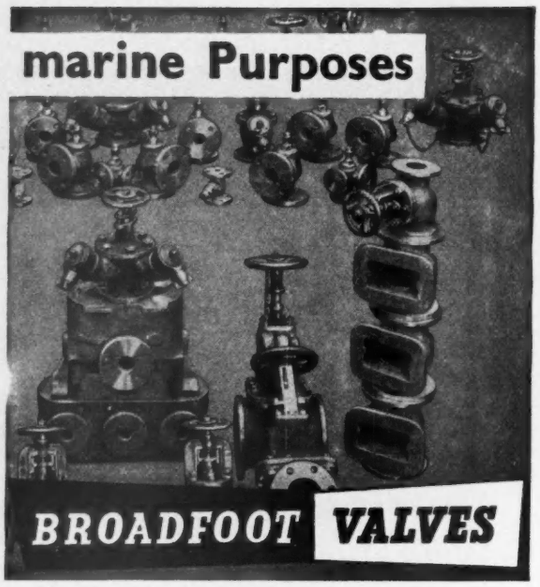

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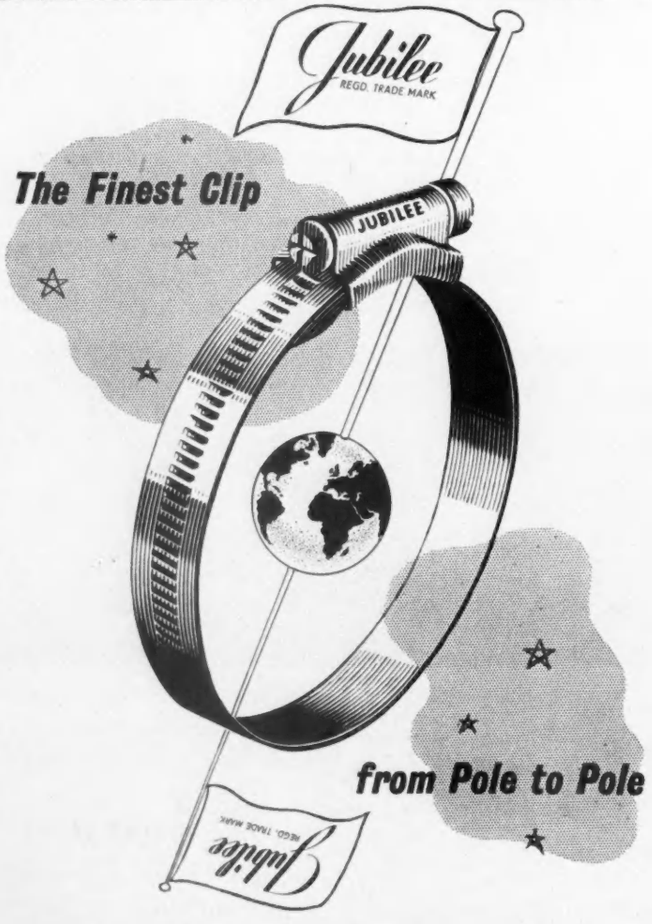

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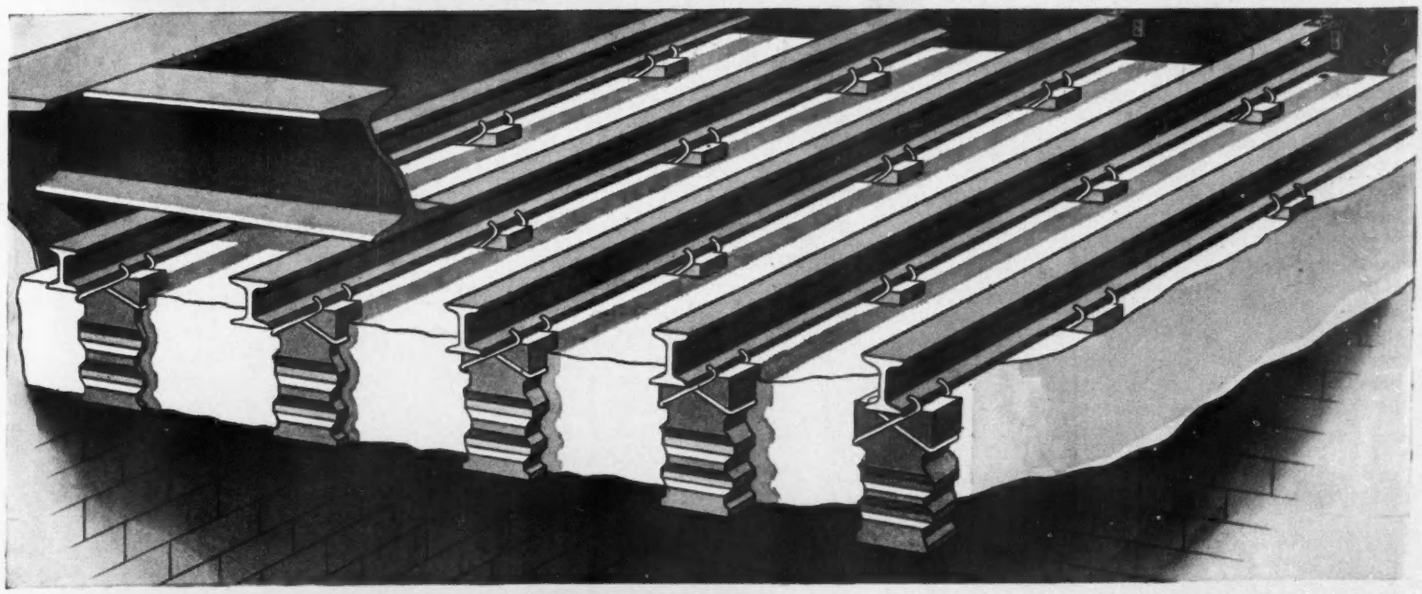

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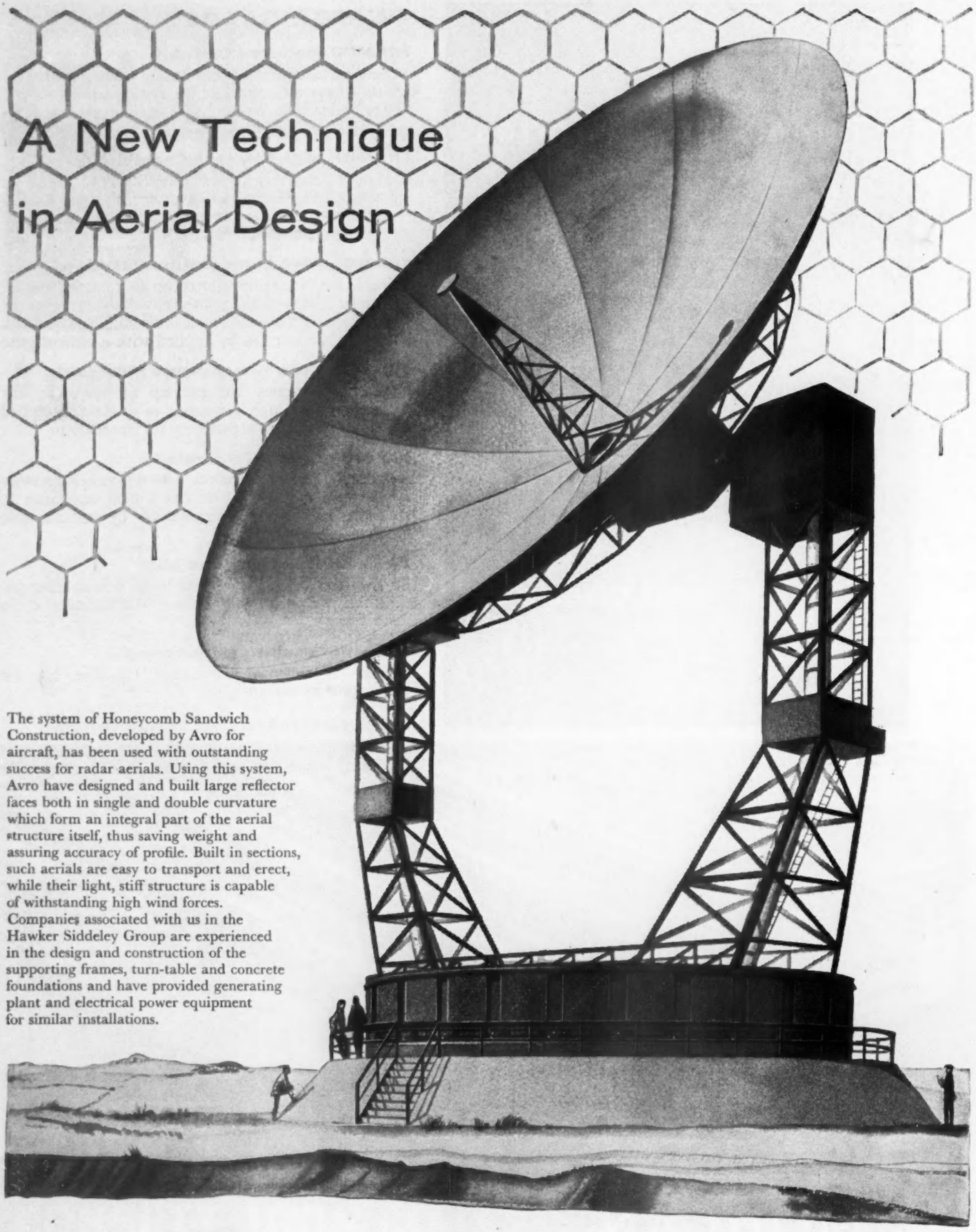

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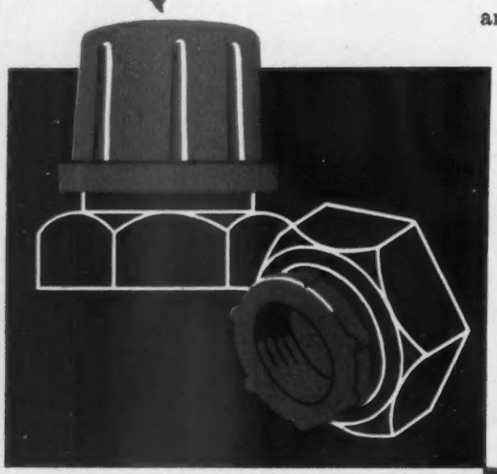

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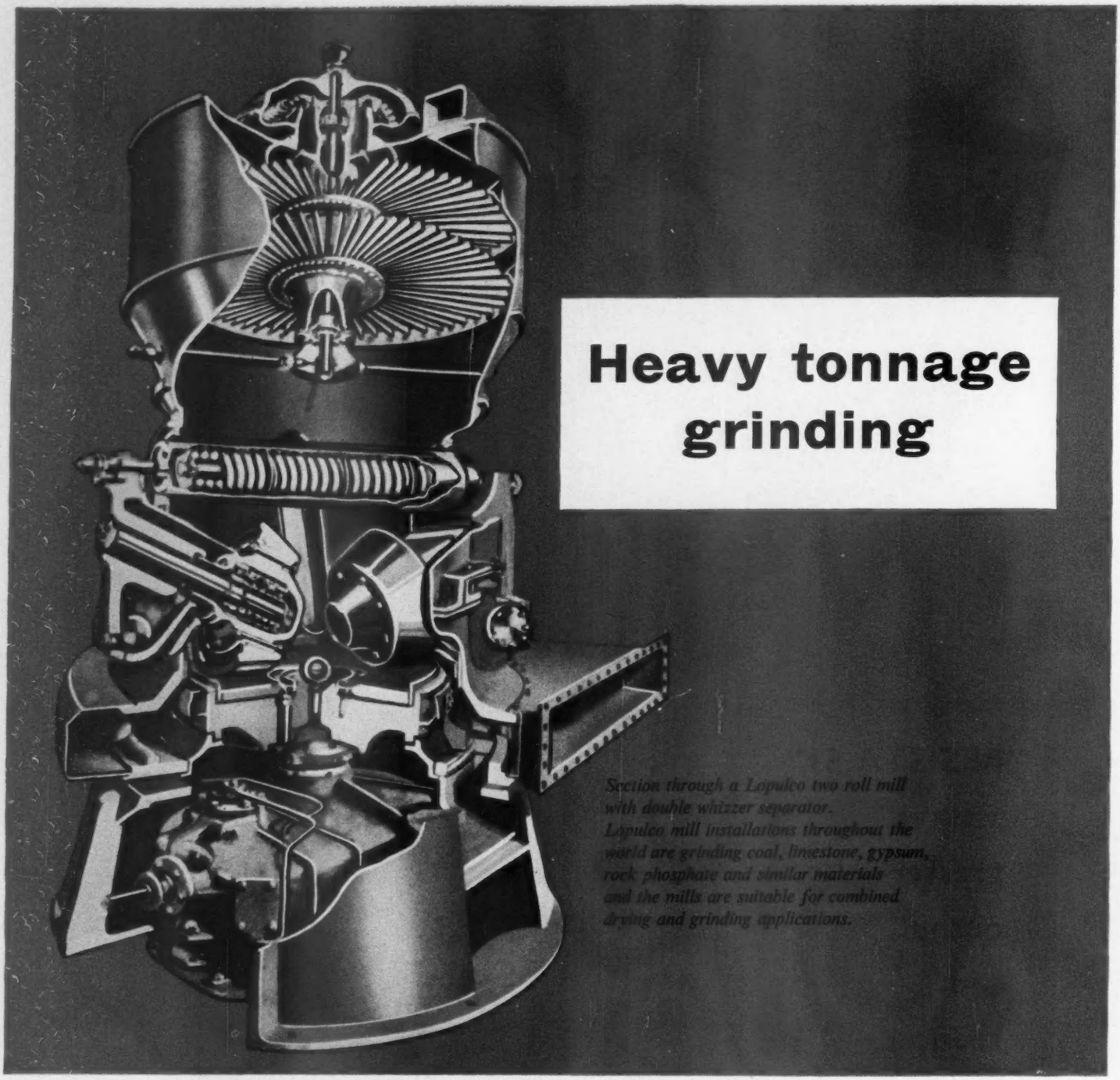

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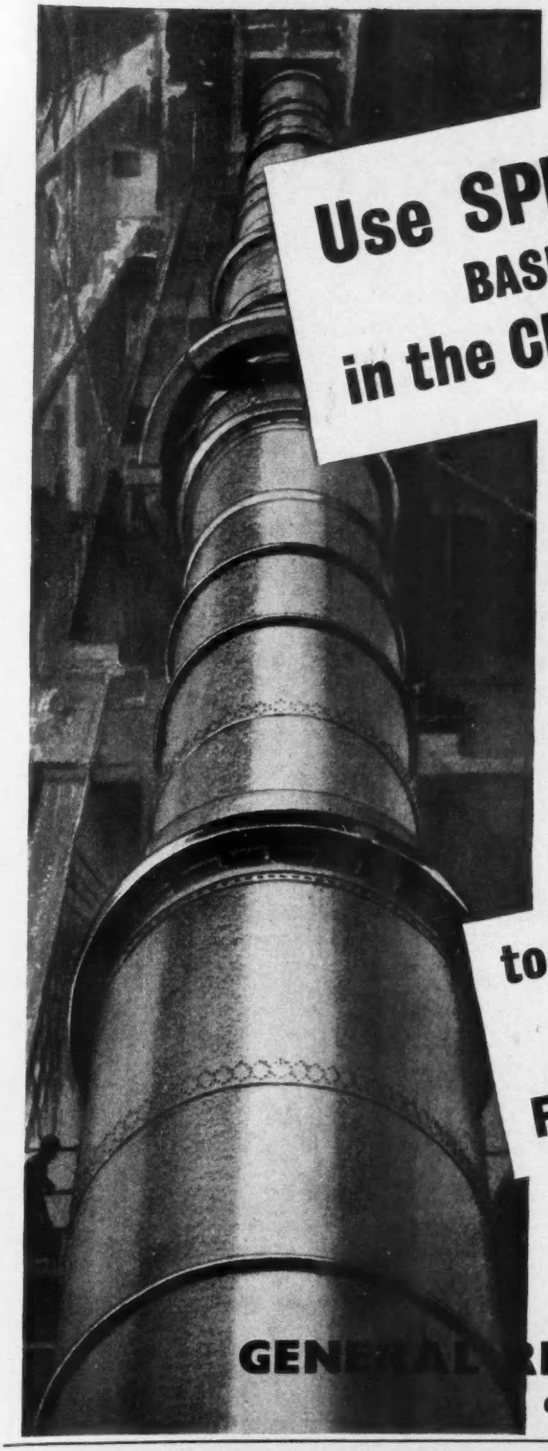

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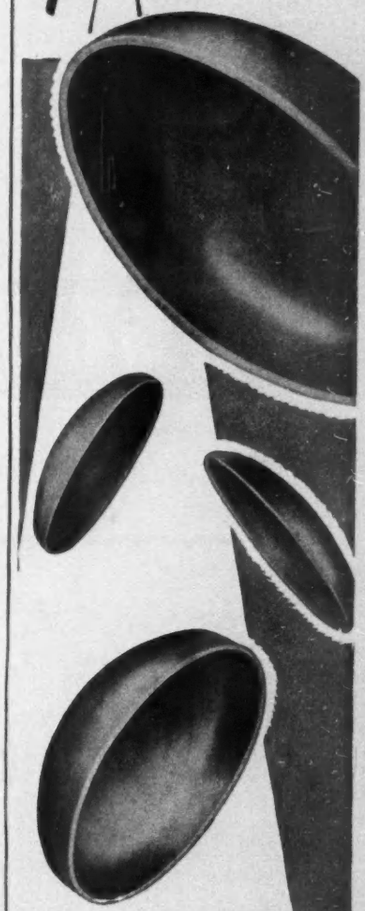

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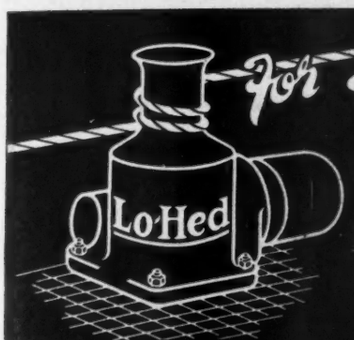

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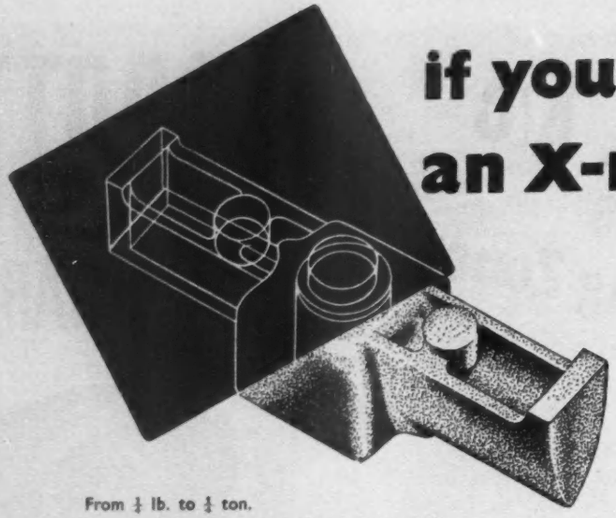

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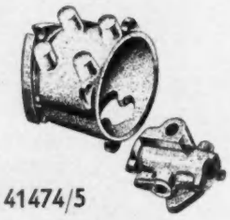

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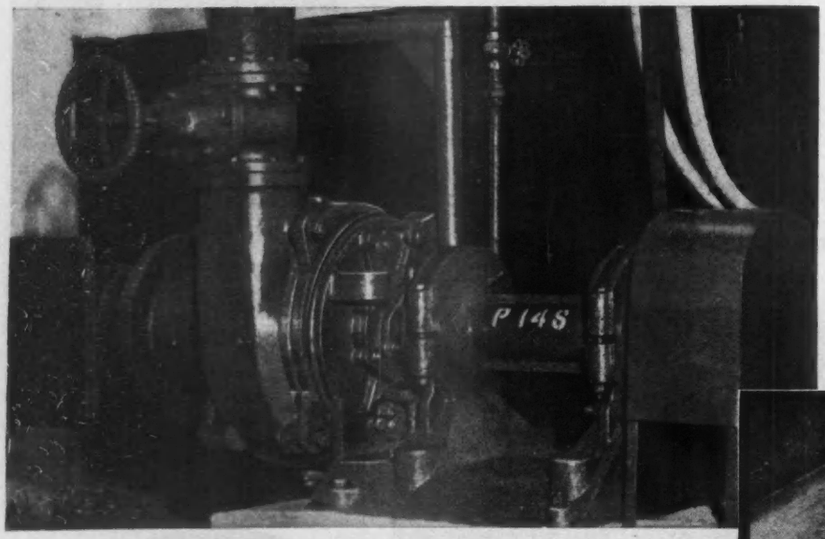

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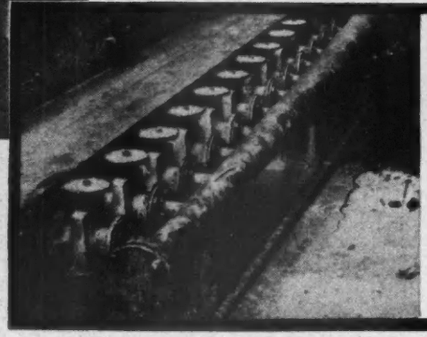

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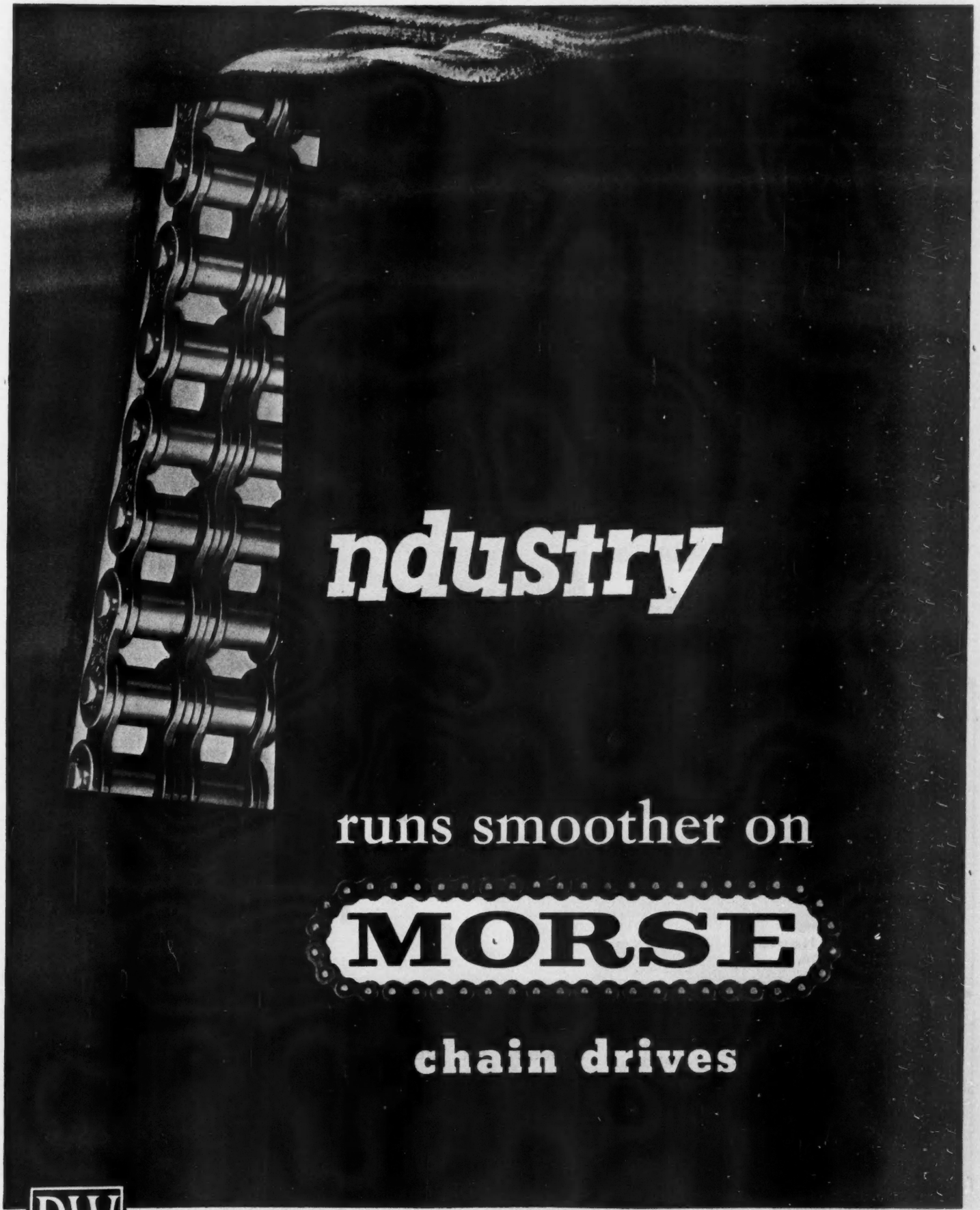

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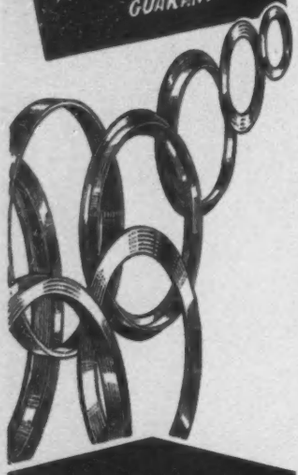

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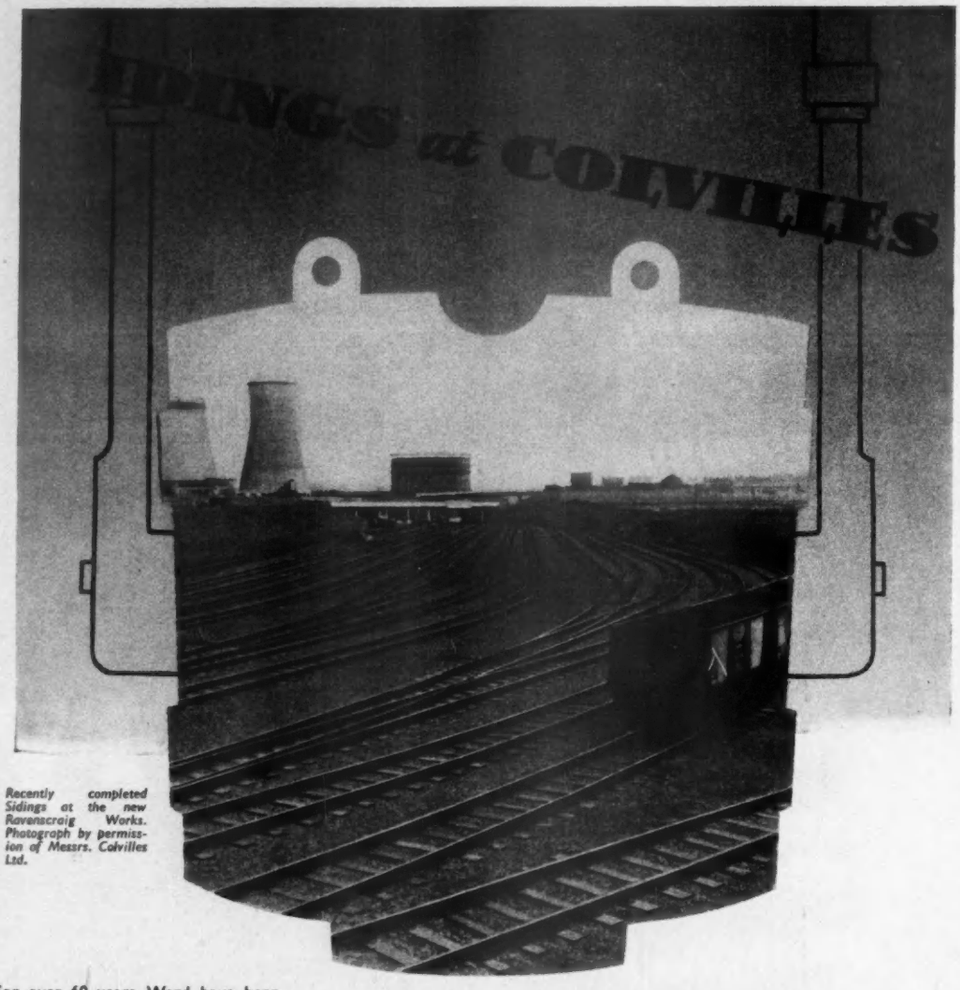

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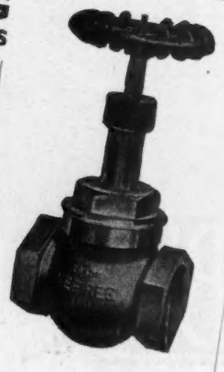

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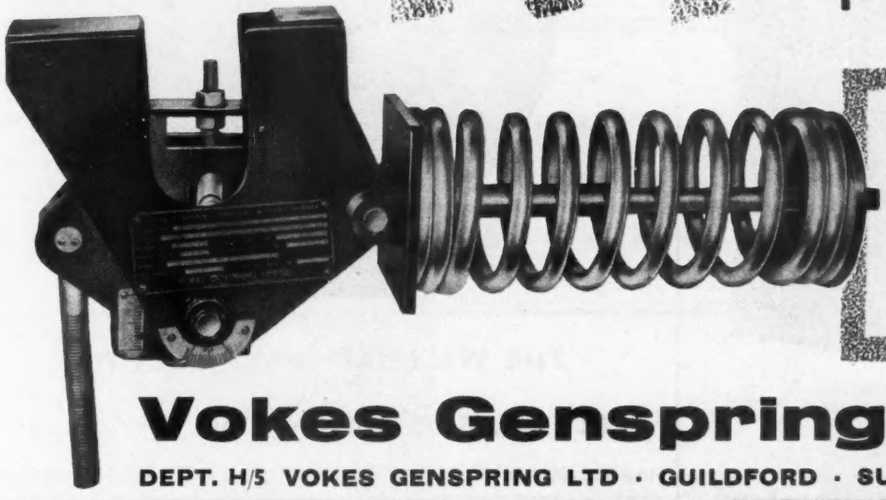

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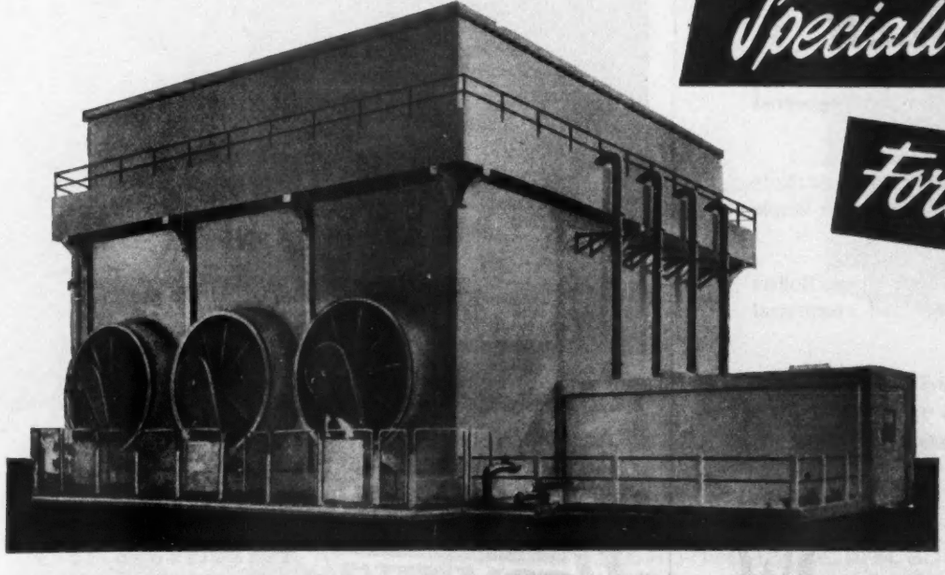

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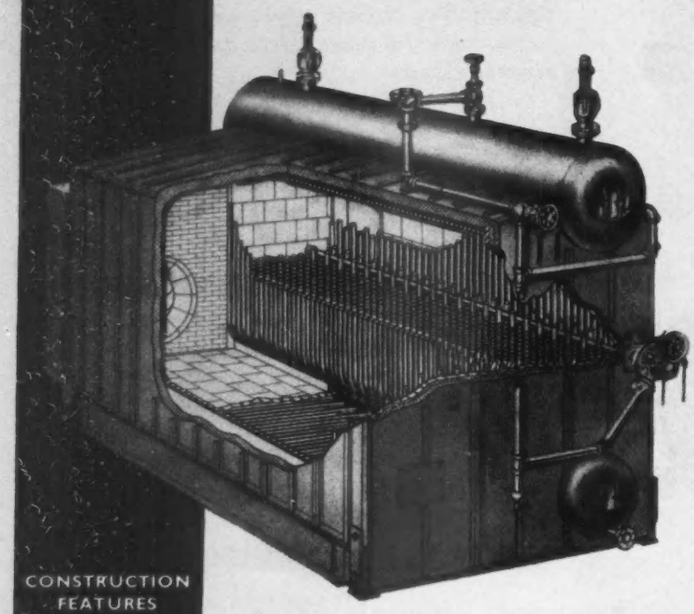

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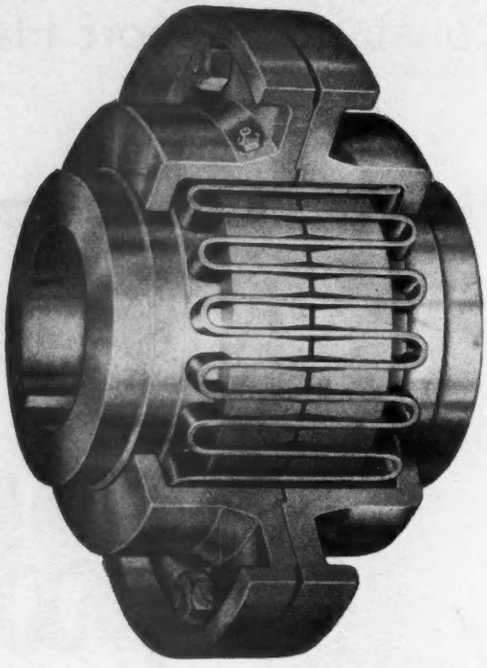

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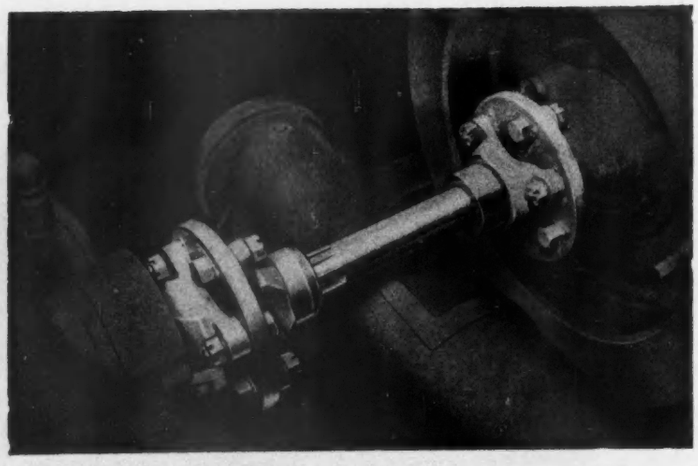

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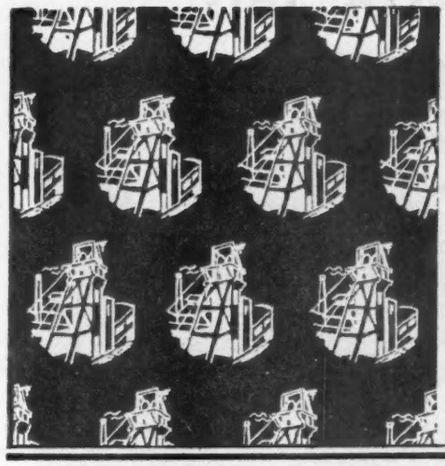

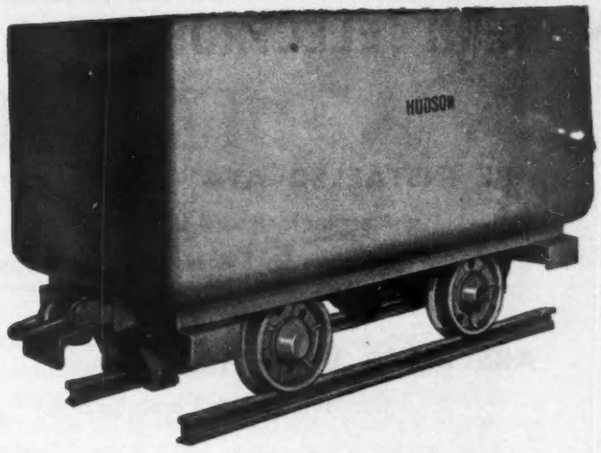

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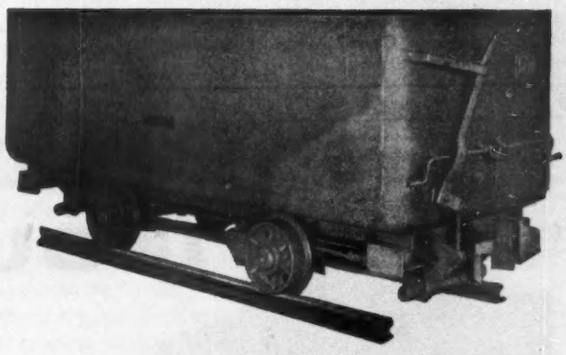

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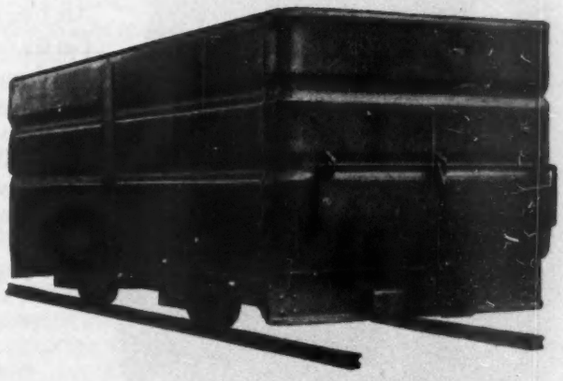

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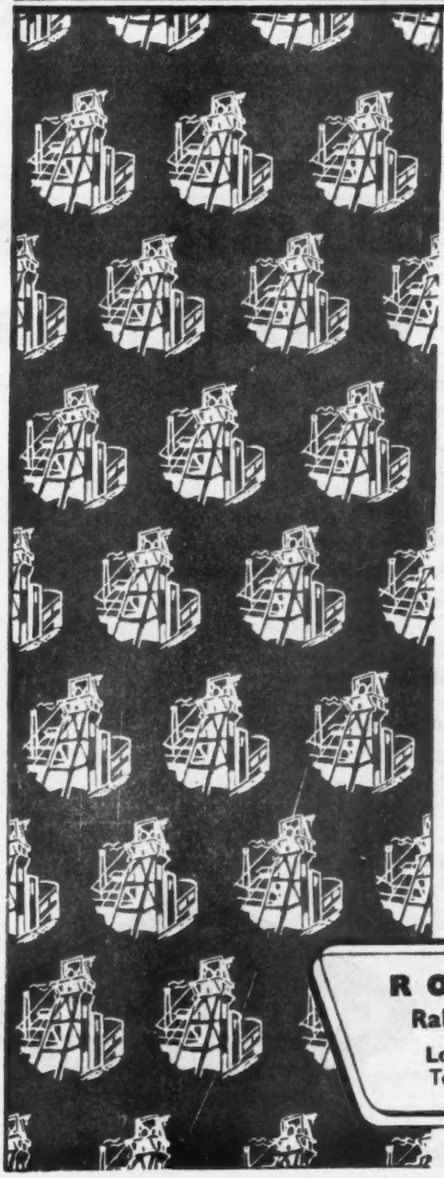

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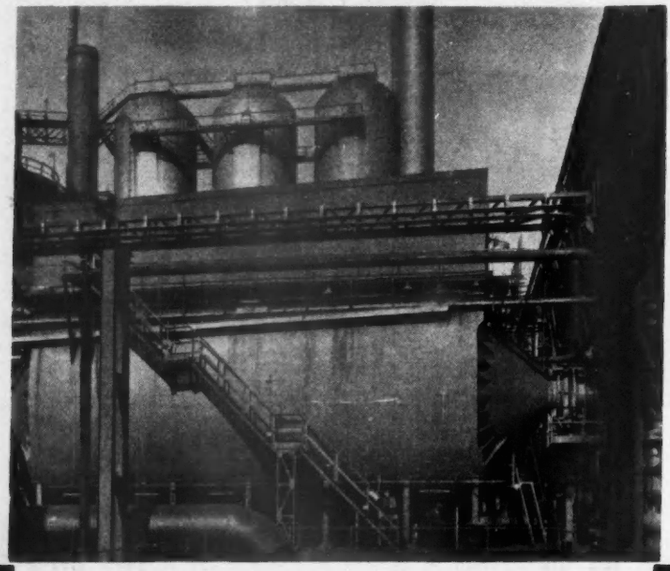

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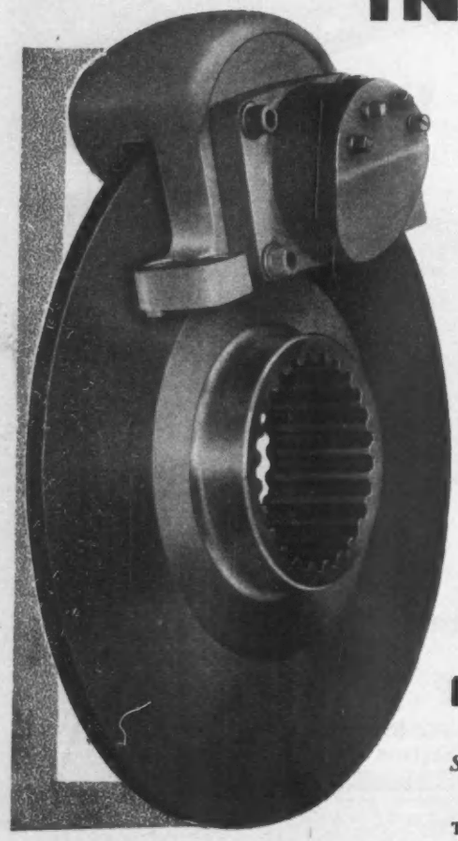

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THE ENGINEER

No. 5341 JUNE 6, 1958 VOL. 205

MORE WORK FOR MERL

A week or two ago we commented on the first report of the new Research Council of the Department of Scientific and Industrial Research. That Council clearly has it in mind that the establishments which come directly under its control should restrict themselves to particular kinds of research work. Pure research should be left to the universities ; and research of more direct application within industry should be done by research associations or by individual firms. That such a definition would still leave plenty of room for D.S.I.R. establishments to continue and to expand their work is now demonstrated by the report, just published, of the Mechanical Engineering Research Laboratory. That laboratory is presided over by a board of which Sir Andrew McCance is chairman and a report to the Council signed by him lists a number of researches which the Board believes ought quite urgently to be undertaken to " assist outstanding industrial developments." None of those researches would be " pure " by university standards ; nor, save for one only, do we think any would prove attractive to industrial research associations, at least until some of the more fundamental groundwork has been done. Research using high pressure techniques, it is felt, would lead to new knowledge of the physical properties of existing materials and, in conjunction with high temperatures, the production of entirely new materials by changing crystal structures. This sounds to be a line of research eminently suited to MERL. Interestingly the laboratory is beginning to give attention to the design of pumps. Anyone who knows anything about the unsatisfactory basis on which pumps are at present designed must admit that an investigation of the theory of blade design ought to have high priority. It should have had it long ago ! Sir Andrew points out that the increasing interest being shown in the economics of pumped storage schemes in conjunction with nuclear power generation makes it desirable to study the problems arising when the same rotor has to be used both as a pump and a turbine. In the decade since it was founded by breaking it away from the N.P.L. the Mechanical Engineering Research Laboratory has become especially well known for its work in the fields of friction, lubrication and bearing design. It is now thought that research in those fields could be extended to cover a greater range of temperature conditions and to cover also the use of low friction bearing materials or chemically treated surfaces in place of liquid lubricants. No other laboratory could so appropriately carry out that work. Research into the development of heat exchangers is, again, work particularly appropriate for the laboratory to undertake. The application would be not only to nuclear power or to gas turbines. There appears to be a possibility that air-cooled condensers might replace water-cooled ones with a substantial simplification of design and operation. The only newly proposed researches which seem to us only doubtfully appropriate to MERL are those suggested into the effects of irradiation on metals such as niobium, tantalum, zirconium and beryllium all of which are or may be used in nuclear reactors. Could this work not be better done at Harwell ; or by the British Non-Ferrous Metals Research Association ? Or is there some special reason, not brought out in the report, why MERL should be entrusted with the work ?

FUTURE FOR FLYING BOATS ?

So much attention has, of late, been directed to the value of the oceans as an excellent hiding place on which to base strategic weapons intended as a deterrent, that there is discernible a tendency to forget what has long been known, that water provides an indestructible flying field. That a marine aerodrome has certain special advantages is frequently noted by the prophets of nuclear-powered aircraft, which are expected to be desperately sensitive to maximum landing weights and may well be unwelcome at airports for other reasons than noise. But the renaissance of the flying boat should not lie so far in the future as this consideration alone would suggest. It is becoming increasingly clear that the equipment to fight a nuclear war is not merely too expensive, but also may be too specialised for tactical, as opposed to strategic, employment ; and we see fresh weapons evolving for this special purpose. An example of such a weapon is afforded by the N.A.T.O. light fighter. The principal reason why special aircraft have had to be built, at the cost of much delay, for a performance hardly ambitious by the standards of to-day, is the requirement that operation from a grass field must be practicable. This is no more than a reasonable demand in view of the immensely enhanced value of mobility in modern war, and it has caused the rapid emergence of many and varied short- or vertical-take-off-and-landing projects. But while the fighter able to land at zero speed by virtue of its thrust, and heavy support transports able to take off from rough or loose surfaces, appear to be almost within our grasp, for many purposes it would be wise to capitalise on the ubiquity of open water. Attack bombers (not the relatively low-powered, flight-refuelling masterpieces of structural and aerodynamic efficiency that execute long-range missions with awe-inspiring deliberation) will require to take off heavily laden but, if they have any evasive capability over the target, should be amply powerful to rise on to step or hydro-ski. It would, we have no hesitation in saying, be rash to assume that there will be no place for the military employment of marine aircraft during, say, the next ten years. But that assumption has very nearly been made in this country. For, with the withdrawal of the " Sunderland " from service—after a career that surely will be remembered even with that of the Bristol Fighter—there are now no seaplane crews in being, and within a few years there will not even be a nucleus to act as instructors or a cadre for any water-based air force. Aircraft can always be bought, at a price, but loyal and trained crews cannot. Surely

at least a token seaplane force should be maintained, if not by a Coastal Command then by the R.N.A.S ?

It would, of course, be absurd to suggest that the equipment for such a force must be developed in this country. The facts that the "Sea Vixen" is far from ready for delivery to the user arm, and that the latest naval aircraft to be revealed, the "N.A.39," is unmistakably a high-subsonic design, show that the industry—or the procurement authority—is already stretched beyond its power to deliver goods. In fact, the Minister of Supply has disclosed that there are at present no plans to construct flying boats in this country. But it has now been recognised that, of the very many kinds of aircraft needed in war and commerce, only a proportion can be built in this country; the remainder will have to be imported, as were the Boeing "Washington," the North American "Sabre" and the Douglas "Skyraider." There is already in production in one of the N.A.T.O. countries an attractive amphibian that has even found a market in the United States, itself the origin of so many fine designs of such machines by Sikorsky, Loening and others. We might well be able to afford to purchase examples of this machine out of the proceeds of aero-engine licensing agreements. A more orthodox approach might be to acquire some of the heavy, long-range American boats that would enable the Navy to give our fishing vessels the protection they may well come to need in the future.

HOW WE THINK

Having just read an address which Sir David Anderson presented to an Engineering Faculty Conference at the Royal College of Science and Technology, Glasgow, last February, we feel strongly inclined to tease him about it. For in the earlier part of his address, which was entitled "Some Current Problems in Technological Courses," he was at some pains to rebut the criticism, often made of technological courses, that students are not being taught to think. Yet later on he remarked that he had "a shrewd suspicion" that many of our mental processes are carried on at a low level of efficiency and he had a feeling that the problem of improving that efficiency might "handsomely repay investigation by experts." Perish the thought which he might possibly be taken to imply that professors dare not attempt to teach students to think merely because they cannot think efficiently themselves! We would not propagate so rude an idea. But in recognising in himself an inefficiency in thinking which many other people will admit experiencing, does he not, effectively, support the argument that universities and colleges ought more deliberately to set out to teach their students how to think ? Moreover, where else could one more appropriately expect to find experts capable of analysing thought processes than at a university or college ?

In thus teasing Sir David, we do so because it seems to us he may really "have" something. How many authors of books or technical papers which have been hailed as models of clear and logical thinking would care to reveal all the murky and humiliating by-paths they traversed in thought before reaching conclusions, subjects of so much praise ? How few of us follow religiously even the most elementary of rules in seeking to think logically ! Do we, for example, always define sufficiently clearly the object of our thinking ? Do we always carefully collect all available information before deriving conclusions ? In rejecting an item of information as irrelevant are we always as careful as we should be to confirm that it really is irrelevant ? It is horribly easy to reject as "irrelevant" what we innately perceive to be a complicating factor or even an inconvenient fact in opposition to some favoured hypothesis which we have formed. Moreover, the more deeply we enter into a subject the more easily we seem to become enmired. To reach the Himalayan peak of our ultimate objective we rush to the conclusion that a lesser peak must first be scaled. Without bothering to check that conclusion we spend hours, days, or months, labouring to master the lesser peak only to have it dawn upon us after a time that its mastering would be an irrelevance ; or that, through a failure to check up on some elementary fact, we have been seeking to climb a sheer face when a simple path goes up the other side ; or that any approach to our lesser peak yields nonsensical conclusions, that it must yield such conclusions, and that it was obvious from the very beginning, if we had not gone rushing up its lower slopes, that it would yield such conclusions ! Indeed, in any process of thinking one of the first difficulties seems to be that of clearing away a kind of rubble of inaccurate, lazy, or emotional lines of thought often leading to preconceived conclusions which we would love to prove right. Another serious difficulty—a much more creditable one—is that of deciding from a mass of possibly relevant information what is, in fact, relevant and what is not. But other humiliating experiences will always follow. By a mathematical process, for example, we find a rate of change of some factor of just the character which may excitingly support an hypothesis which we favour. We chase off into a whole set of intricate subsidiary calculations leading, unaccountably, nowhere, before discovering that the rate of change refers to x and not, as we had rashly concluded, without a check, to y ! And so it goes on ; we stagger from one abysmal error to another. A genius, no doubt, perceives how to get directly towards his objective in thought. He never leaves the straight and narrow road. The rest of us go stumbling around beating our heads against brick walls and exploring the detail of blind alleys. We reach the truth by a process of elimination, having tried first to prove almost all possible erroneous hypotheses the true ones ! Would it not be worth while setting up a Chair of Original Thinking somewhere to teach us how to avoid making such asses of ourselves ? But perhaps the logicians would claim that they have done just that already !

COURSES IN TECHNICAL AUTHORSHIP

We are glad to note that, following up its establishment of a course and examinations in Technical Illustration the City and Guilds of London Institute has now drawn up a syllabus for a course and examinations in Technical Authorship. The preparation of such a syllabus has probably proved as difficult a matter as the preparation of one in Illustration no doubt turned out to be. For there are aspects of authorship which cannot in any ordinary sense be taught. A man may never make a mistake in English grammar and he may arrange his material logically and express himself quite clearly. Yet the result may be so dull that no one will read it ! Writing attractively is in fact an art. Nor do we agree with the suggestion which is frequently made that there is a kind of utilitarian technical English which anyone can quickly learn to use. English is so flexible a language and its shades of meaning are so dependent on context and word arrangement that proficiency in its use can only be attained by constant practice. Fortunately that point has been recognised. Much attention is given in the syllabus to such things as grammar, presentation, and words and their meanings, besides, of course, more technical matters

related to methods of reproduction, format, type-faces, binding, &c. But in "Notes for the Guidance of Teachers" it is strongly emphasised that "students cannot be taught to write well merely by being lectured to; and it is suggested that a high proportion of the course time should be given over to a progressive series of exercises in technical writing." Further, "the great value of criticising, amending, re-drafting and re-arranging examples of unsatisfactory technical writing should not be overlooked." The intermediate examination will be offered for the first time in 1960 and the final examination in 1961. An increasing number of firms, more particularly in the aircraft and motor-vehicle industries and in electrical and electronics manufacture, not to forget the Armed Forces, are taking an interest in issuing really well produced instructional books, catalogues, monographs and other technical material. There should be plenty of room in industry for men who have successfully completed this new course. The standard to be attained for entry ranges from an adequate command of English at General Certificate of Education, Ordinary Level, plus a completed engineering apprenticeship to "a suitable university degree or higher diploma plus two years practical experience." But we confess to wondering how any college will be able to devise a course, within the syllabus, from which men of such very different educational attainments will simultaneously benefit. It will be interesting to see the outcome.

PUBLIC CITY TRANSPORT

One of the less expected consequences of the London bus strike has been the proposal seriously put forward in a letter to *The Times* that buses should henceforth be banned from inner London! For instead of the traffic congestion that everyone feared would be a consequence of the disappearance of the buses there has been less congestion. Only the parking of cars has proved a problem. It can hardly be doubted now—for the number of private cars is rapidly growing—that public surface transport of passengers in this country is likely to experience the same steady fall in usage that it has experienced in American cities. Sir John Elliot and other economists and organisers may argue convincingly that it would be better to ban the private vehicle from central London. But, in fact, comfort and convenience clearly mean more to many people than cost. We suspect incidentally that it is the same factor of convenience rather than economy that makes the C-licence lorry so attractive. The L.T.E. is thus in a cleft stick. For if in face of a demand by busmen that their wages should be raised fares had to go up, further impetus would be given to the already observable trend of falling traffic; and since the L.T.E. depends on bus profits to outweigh a deficit on its rail operations a fall in bus traffic might necessitate an increase in fares all round! Nor in an unprofitable and contracting industry can the wage-earner be expected to consent to carry "the baby" by accepting low wages. One answer, of course, might be to ban the private car (and the motor-scooter ?) from a large area of central London altogether, thus forcing the public to travel by rail, and bus; to refuse to make provision for the parking of private cars; and to limit road improvement to the minimum. That is a solution which might appeal to the Treasury and to the L.T.E. But it is very improbable that it would be accepted by the public. For it runs counter to the whole trend of development. Instead it would be better to accept the trend and study how evolution towards a city whose workaday inhabitants will in the future come to it increasingly by private transport can be so treated as to make the falling activity of public transport occur as painlessly as possible to all concerned.

DANGER OF WORN-OUT HAND TOOLS

We have little faith in horror posters. We do not believe they are any more effective than less bloodthirsty affairs. For it is a strange but probably invaluable quality in human nature that none of us ever believes that an accident will befall us. It is always the other fellow who is due to get hurt. Thus we think posters tending to arouse interest in other people's safety are more effective than those, such as horror posters, designed to make individuals appreciate dangers to themselves. But though in a new campaign it is about to begin the British Safety Council is to use horror posters (of which we disapprove), we have nothing but praise for the object of the campaign. According to Ministry of Labour official statistics, unserviceable hand tools inflict only about 14,516 injuries per year. But the Council believes these figures are definitely misleading. We can well believe it; so will all engineers who, as part of their training, have spent many months in an engineering works. For the Ministry's figures relate only to accidents incapacitating workers for three days or more, whereas many minor injuries inflicted by worn-out hand-tools will keep workers out of production only for a few hours. The Council assesses the number of injuries thus inflicted as around half-a-million a year; hence its campaign to stress the need to scrap worn-out and damaged hand tools. We hope the campaign will prove effective.

The Engineer — 100 Years Ago (JUNE 4, 1858)

"BLAST FURNACES ON THE TYNE"

"The discovery of large beds of ironstone in Cleveland and other parts of North Yorkshire, in addition to creating an extensive trade on the Tees, has latterly given a considerable impetus to the iron trade on the Tyne, as shown by Messrs. Wm. Beverley and Co. having built four blast furnaces at Jarrow, a small village on the Tyne, about four miles below Newcastle, which, from their large size and the completeness of their arrangements, are creating considerable interest among the engineers in the North of England. The works are connected by the Poulop and Jarrow Railway to the important coalfields of Northumberland and Durham, and have river frontage to the Tyne, with wharves, fitted with Armstrong's hydraulic cranes, especially adapted for delivering the ironstone, which is brought principally from Staithes, a small village on the coast near Whitby, by screw colliers on their return from London, after delivering coal.

"Mr. A. Slate, the eminent engineer, was appointed consulting engineer to the company, and, in conformity with his experience in the Cleveland and other districts, the furnaces were made of the following large dimensions: Height from ground to charging holes, 60 feet; height from charging place to top of head, 13 feet; diameter at boshes, 17 feet 9 in.; diameter of hearth, 7 feet..... The blast is produced by five of Slate's high-speed engines, with blowing cylinders 50 in. diameter and 2 ft. 6 in. stroke, each capable of blowing 6,000 cubic feet of air per minute, at a pressure of 3 lb. per square inch, the engines running eighty revolutions per minute.... The blast is conveyed by a 4 ft. diameter tube to the heating stoves (ten in number), which are of the usual U pipe construction, and from thence, by an 18 in. diameter oval iron pipe to the five tuyeres by which each furnace is supplied.... Two of the furnaces are now in blast, and give promise of producing a very large quantity of iron."

Sugar from Beet

No. I

Every year between 4,000,000 and 5,000,000 tons of sugar beet are grown in this country on about 400,000 acres of agricultural land. The British home-grown sugar industry has a long history, though it is only in the last twenty years or so that it has become firmly established. Mechanisation of all stages of beet cultivation and harvesting has done much to further the industry's progress. Here we deal with the mechanisation of beet growing.

THE first successful attempt to produce sugar from beet was made by a German chemist, Andreas Marggraf, in 1747. But many years went by before the manufacture of sugar from beet was tried in this country. In the middle of last century there were a few sporadic attempts made, in Essex and elsewhere, to encourage the growth of beet for making sugar, but they had then to be written off as failures. It seems, however, that a certain amount of propaganda for the crop continued and many people came to realise that sugar beet could be satisfactorily grown in this country. Nevertheless, investment for the erection of processing factories was not attracted, and in the early years of the present century it did not appear at all likely that a British home-grown sugar industry would be established ; cane sugar could be imported at a low price.

The pioneering efforts, however, went on, and in 1912 the first modern sugar factory in this country was built, mainly with Dutch capital, at Cantley, in Norfolk. The operating company managed to persuade farmers in the area to grow enough beet to keep the factory going for four seasons, but the venture was a loss financially and in 1916 the factory was closed. By then, of course, sugar supplies had become seriously curtailed through the exigencies of the first world war. In 1917 the Government gave approval to a scheme for granting financial aid for sugar beet cultivation. This was one of the factors which led to the re-opening of the Cantley factory in 1920, and a year later a second factory was opened at Kelham, in Nottinghamshire. But financial difficulties continued to hamper the progress of these factories, and the failure of the home-grown sugar industry was only averted by the remission of excise duty on home-grown sugar, and, subsequently, by Government subsidy. The arrangement about the latter was that, from 1924, there should be a subsidy on home-grown sugar which was to be progressively reduced over the succeeding ten years as the industry gained experience and became able to cut its production costs by more efficient working. An Act of Parliament to authorise this was passed in 1925.

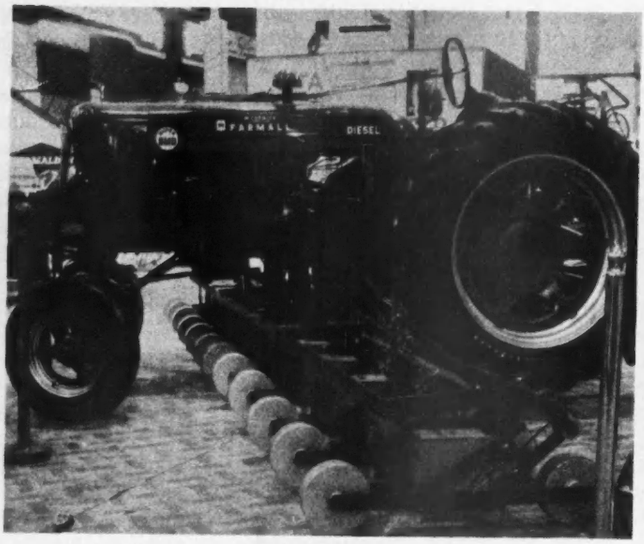
Before that ten-year period had elapsed the eighteen factories (seventeen in England and one in Scotland), which are now operating, had been built. Under the terms of the Sugar Industry (Reorganisation) Act, 1936, the British Sugar Corporation was established and became the authority responsible for all the factories and, indeed, for the whole business of home-grown sugar production. The acute shortage caused by the events of the second world war gave fresh impetus to sugar manufacture in Britain, and in the post-war years the necessity for restricting imports from dollar countries has further enhanced the value of home-grown sugar. During the war the Government became responsible for fixing not only the price at which the British Sugar Corporation bought its beet, but also the prices at which it could dispose of its products, namely, sugar, sugar beet pulp and molasses.

The most recent legislation affecting the beet sugar industry in this country is that embodied in the Sugar Act, 1956. By this Act a Sugar Board was set up, the principal functions of which are to buy Commonwealth sugar and to sell it commercially, and to control imports under the International Sugar Agreement. The act also empowers the Government to enter into agreements with the British Sugar Corporation for promoting economy and efficiency and for the making, by the Sugar Board, of incentive payments to the Corporation. The transactions of the Sugar Board and of the British Sugar Corporation, it may be noted, result in a surplus or deficit according to whether receipts from the sale of sugar are above or below the respective costs of Commonwealth sugar to the Board and of home-grown sugar to the Corporation ; any deficit of the Corporation is made good by the Board, and any surplus accrues to the Board. The price paid to farmers by the British Sugar Corporation for beet is fixed by procedure specified by the Agriculture Act, 1957, and the Sugar Act, 1956, and contract conditions for beet cultivation are arranged between the Corporation and farmers' representatives. A great deal of research work is also undertaken by the Corporation in co-operation with scientific organisations and the universities.

This survey of the history and present organisation of the British sugar industry has been included here in the hope that it will give a general idea of how the business of producing sugar from beet is carried on. It can certainly be said that the home-grown sugar industry is a progressive one. In addition to its expanding research work, the British Sugar Corporation, in the last ten years or so, has spent about £10,000,000 on new buildings and plant, detailed reference to which will be made later in this article.

In Great Britain at the present time there are approximately 40,000 farmers who grow sugar beet. About 400,000 acres are devoted annually to the crop, the largest single concentration being in East Anglia. In a normal year, the beet production from this acreage is between 4,500,000 and 5,000,000 tons, from which an average of over 500,000 tons of white sugar may be procured, as well as 300,000 tons of dried beet pulp and 175,000 tons of molasses.

In the last ten years in particular a great deal of attention has been paid by agricultural engineers to the mechanisation of all aspects of sugar beet cultivation and harvesting. In this matter the research work initiated by the British Sugar Corporation has been—and still is—most valuable. It may seem a little strange, at first glance, that the first stage of the " mechanisation process " should have been concentrated on the harvesting of the beet crop. But beet harvesting, by hand alone, required far more labour than was available during the war and in the succeeding years. It is an operation which has to be completed in a short period, usually in ten to twelve weeks from the end of September. It will quickly be appreciated that to lift, top and load by hand 5,000,000 tons of beet would be a well-nigh impossible, as well as a thoroughly uneconomic operation in these days of a declining agricultural labour force. More recently, however, " spring mechanisation," i.e. such operations as drilling beet seed and thinning out the young plants, has commanded the close study of engineers. Thus, there are now machines available for every stage of sugar beet cultivation, harvesting and loading for despatch to the sugar factories.



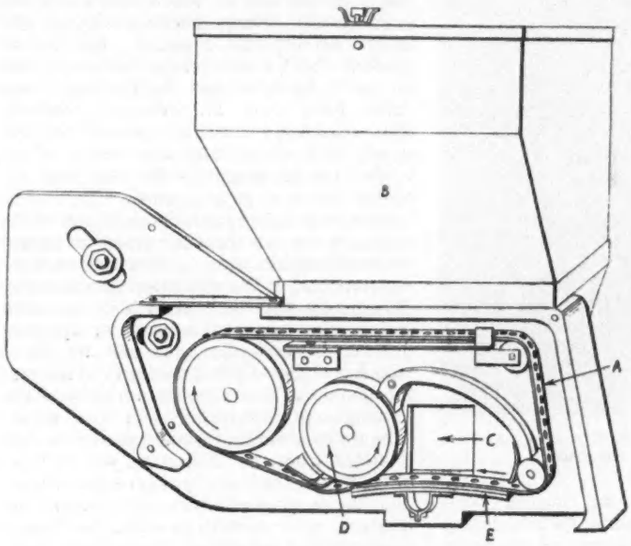
Stanhay twelve-row precision drill mid-mounted on a tractor. The drill frame is 22ft 6in wide

Precision Drilling

In the cultivation of sugar beet care needs to be taken over the " plant population " in order to obtain the most satisfactory crop. Experience over the years and the research of recent times have shown that, for the conditions which prevail in this country, a " population " of between 25,000 and 30,000 plants to the acre is desirable.

In order to minimise the work of thinning and singling the young plants, precision drilling of sugar beet seed has steadily gained favour in the last few years. Several agricultural machinery makers have developed drills of this kind, and progress was undoubtedly encouraged by a competition organised in 1953 by the Sugar Beet Research and Education Committee (THE ENGINEER, April 24, 1953). As one example of the precision drills now available, that designed and manufactured by Stanhay (Ashford), Ltd., Ashford, Kent, may be cited. It consists

essentially of a number of separate drilling units which are attached to a toolbar frame normally mounted at the back of a tractor. The usual practice is to build up a four- or five-row drill in this way, though we have been informed that last year quite good results were obtained by using eight of these drilling units on one toolbar frame. The development of the Stanhay drill is now being taken a stage further, for at the Smithfield Show last December the firm exhibited the twelve-row drill which is shown in one of our illustrations. In this case the drilling units are attached to a mid-mounted toolbar frame which is 22ft 6in wide ; the frame is built in three sections, the centre one being 9ft wide. The main drive to the drill units is taken from the rear wheel of the tractor so that all the units are driven at a uniform speed in relation to forward movement. From the main shaft, there is an independent belt drive to each drill.



Arrangement of Stanhay drill unit

The operation of the drill units will be best understood by reference to the accompanying drawing. The seed is fed from the hopper *B* into a small chamber *C* immediately above the endless belt *A*, which is holed at intervals and which travels in the opposite direction to the drill. A repeller *D* stirs and agitates the seed so that each hole in the belt picks up one seed ; it goes partially through the belt and is conveyed over the spring base *E* to the rear of the coulter. This coulter has been designed to make a small vee-shaped furrow for the reception of the seed, the point of ejection being at the end of the spring base *E*. Each drill is provided with a rear driving wheel, just in front of which there is a simple device, attached to a drag chain, which acts as a coverer before the soil is consolidated by the progress of the wheel. To enable the tractor driver to see that the drills are operating satisfactorily, an electrical seed belt indicator and hopper monitor have been devised. Each drill unit is fitted with a contact make-and-break actuated by the seed belt ; the contact is connected to a control panel on the tractor and the current is taken from the tractor battery. For each drill the panel carries a light which flashes all the time the seed belt is turning, so that as soon as a light leaves off flashing the driver knows which particular drill is not functioning. As the seed is used at the same rate from all the drills, the hopper monitor is fitted to one " master " hopper. A float in the hopper breaks contact when the seed reaches a predetermined level and the green indicating light on the panel goes out.

It should be added that there are other designs of precision drills. Most of them incorporate a revolving plate at the base of a seed hopper, the plate being holed or notched at intervals to permit the individual seeds to be dropped into a tube through which they pass to the ground. With precision drills of all designs, however, one important factor is that the seed must be deposited either direct into the seed furrow or else through a very short coulter tube. If the seed has to pass down a long coulter tube, its regular distribution can be disturbed and the benefit of an improved seed-delivery mechanism is wasted. The efficacy of precision drilling is, of course, closely linked with the use of seed of greater " singleness " than the natural beet clusters.

Mechanical Thinning

As mentioned above, a " population " of 25,000 to 30,000 plants an acre is considered desirable for sugar beet in this country. Hoeing and thinning the young plants were operations that used to be regularly performed entirely by hand labour. But in recent years, there has been steady progress with the mechanisation of these operations and a number of tractor-mounted steerage hoes have been developed. The designing of machines for thinning out the beet crop, however, has posed a number of problems ; such machines cannot, for example, be operated really satisfactorily unless from the start there is a good level seed bed for the crop. The researches into mechanical thinning which have been carried out by the National Institute of Agricultural Engineering and by the British Sugar Corporation have produced useful results, and even though there are occasions when some hand work may still be necessary after mechanical down-the-row thinning, the use of a machine has reduced it to a fraction of what it used to be.

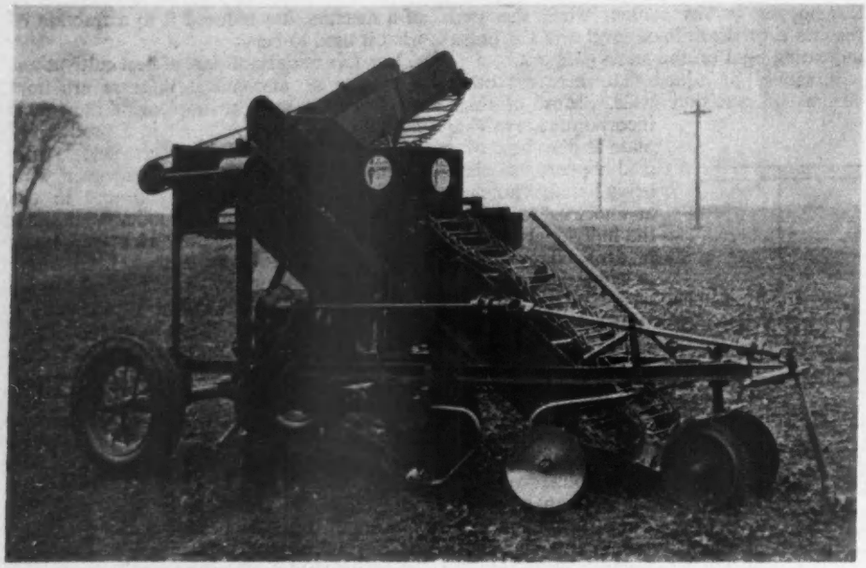
For this important part of beet cultivation, a number of mechanical thinners are now on the market. The implement illustrated below is an example ; it is a product of Massey-Ferguson, Ltd., Coventry. This thinner comprises a tubular member with bearing brackets at each end and in the centre. Two half-shafts are mounted in these bearing brackets and are driven from their respective land-wheels. Tine head drive units—either four or five in number—are mounted on the half-shafts. These units are arranged so that the direction of rotation of each tine head is the opposite of that next to it ; this is done to eliminate side draught caused by the rotating tines. The four-row implement, incidentally, can be extended to accommodate six tine heads. The tine head units are individually spring loaded and their tension can be further controlled by a hand lever operated from the tractor seat. The cutting tines in each head are quickly replaceable and their working depth is controlled by an adjustable depth wheel which is clamped to the side of the tubular assembly member. A " count stick " for assessing the extent of the beet crop and a front axle pointer for ease of steering are also part of the equipment. The implement is designed to travel 28in along the row for one revolution of the cutting tine head, allowance for wheel slip being made in the gearing ratio. With a head carrying six tines, an advance of 4·66in along the row is obtained before a tine reaches the position the preceding one held. The cutting tine blade, which is inclined at an angle of 24 deg., will remove a greater portion of the row than its length, because of the advance of the implement along the row. With six 2½in tines on each head, 50 per cent of a crop will be removed in the first thinning. A second treatment—in the opposite direction a few days later—will reduce the plant count further, depending, of course, on the tine selection used.

Work on the further development of mechanical thinners, as well as of drills and other " spring season " equipment, continues. Its progress is undoubtedly assisted by the " spring mechanisation " field demonstrations that are now held annually. This year's demonstration took place at Wittering, Lincs, last week; at it over fifty machines were operating.

Beet Harvesting

As we have already noted, this country's sugar beet crop is grown by about 40,000

Massey-Ferguson " down-the-row " thinner



Catchpole beet harvester which "tops" one row in advance of lifting the roots

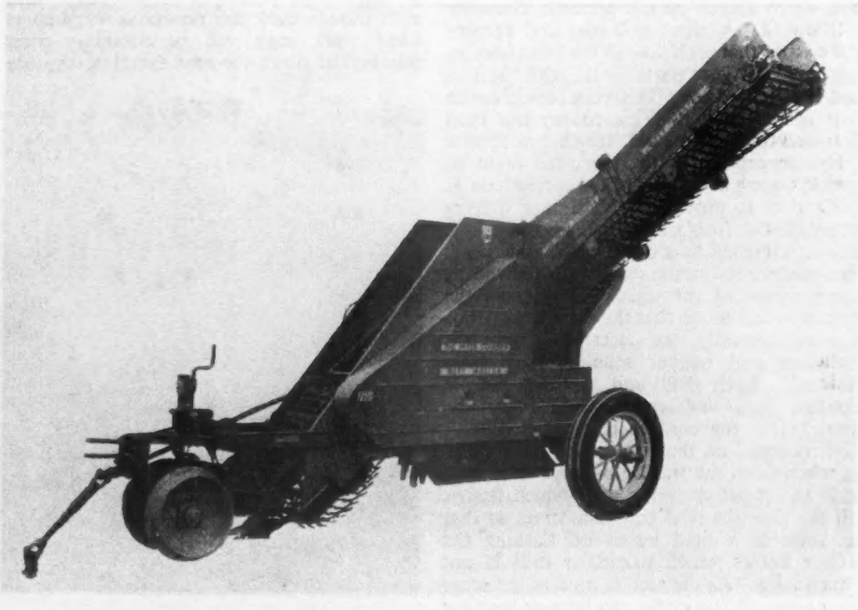
farmers and occupies approximately 400,000 acres every year. The grower's crop is purchased by the British Sugar Corporation at a "specified price" per ton of properly topped and cleaned beet containing 15½ per cent sugar. This means that the contract price is for 15½ per cent sugar; it rises or falls if the sugar content is above or below that percentage. The matter of topping is important, the agreed level being where the lowest leaves or buds on the crown of the beet have grown. The crop is harvested as determined by the contract with the growers; normally it is a continuous process from the last week in September, deliveries being made by the growers until the factories close, usually early in January. The harvesting period is thus not a very long one, and much of the work frequently has to be done when the weather conditions and, consequently, the state of the land are bad.

A traditional method of beet harvesting, but one which demanded a large labour force, was to loosen the roots with a horse or tractor-drawn implement, pull them out of the ground by hand, knock the roots together to remove the soil, and place the beet in rows ready for topping. The tops were then severed by hand choppers and the beet had to be loaded on to carts or lorries for the first stage of its journey to the sugar factory.

The complete mechanisation of the harvesting operation was seriously taken in hand in this country towards the end of the second world war. In 1946, the British Sugar Corporation, in co-operation with the National Agricultural Advisory Service, organised its first demonstration of beet harvesting machinery. In the 1946 harvest, 118 harvesting machines were worked, but they were able to deal with no more than about 1 per cent of the total acreage. In the next two or three years, progress with the development of mechanical harvesting can best be described as "steady." By 1950, the British Sugar Corporation was able to report that 16 per cent of the annual crop of 400,000 acres was machine harvested. In the "campaign," as it is termed, which has just been concluded, it is believed that nearly 55 per cent of the total crop was handled by machines. It should be explained that "campaign" refers to the factory manufacturing period; the actual harvesting period is less. The harvesting machinery demonstrations, which continue to be organised annually by the British Sugar Corporation in the various beet-growing areas, have undoubtedly contributed much to improving the design and encouraging the more efficient operation of the beet harvesters that are now available.

Beet harvesting machines can be put into two main classes. The first covers "combined" machines which will top, lift and clean the beet and leave them in heaps or rows or elevate them into an accompanying truck; there are also two-unit machines which carry out the operation in two stages. The first stage is the topping of the beet and the second is lifting them from the ground and dumping them in rows or heaps for loading subsequently. There is an obvious advantage about the combined machine in that the whole business of harvesting is done in a single operation. But, inevitably, the problems surrounding the design and construction of these machines have been many, especially when it is kept in mind that a high degree of efficiency is expected of them under sticky conditions on the land. It is essential for the beet to be satisfactorily topped, lifted without damage to the root, freed from as much dirt and trash as possible, and loaded without stones and clods finding their way up the elevator! These are some of the major matters that have had to be taken seriously into account by the designers and manufacturers of combined beet harvesters. We illustrate one or two examples of the combined harvesting machines now in use in this country and overseas. The first of them is the "Cadet" side elevator model produced by Catchpole Engineering Company, Ltd., Bury St. Edmunds, Suffolk. This machine, which is operated by the power take-off shaft of the tractor which hauls it, is arranged so that the beet are topped one row in advance of lifting. The topping unit incorporates feeler wheels which guide the tops to the knife which is carried on an adjustable arm. A setscrew and locking nut form a variable stop against which the topping knife is held by a compression spring; by turning this setscrew, a greater distance between the knife and the feeler wheels is obtained if it is necessary to increase the amount of crown cut from the beet. The topping unit, incidentally, is chain driven from the landwheel of the harvester. As may be noted from the illustration, just in front of the topper there is a spring-loaded concave disc, the purpose of which is to cut through weeds or other rubbish to assist the efficient functioning of the topper. Behind the topper there is a spinner, fitted with rubber beaters, for clearing to one side the severed tops and leaves. Both topping unit and spinner are adjustable for dealing with row widths between 16in and 26in. The topped beet are lifted from the ground by heat-treated steel digging shares which are located at the foot of the elevator frame. The furrow slice from these shares is received between an upper and lower rod link conveyor, the beet being gripped between the flexible upper and lower conveyor and moved along to the hopper. From there they pass to the elevator, which discharges them into a truck running alongside the harvester. The rod link conveyors are operated by steel sprockets with teeth specially designed to prevent blockage of the conveyor by stones; the links are of tempered alloy steel. Adjustment to obtain the correct working depth for the harvester is made by raising or lowering the two front wheels.

Another "combined" machine illustrated



Peter Standen "Beet Master" harvester equipped with "Wavikleen" conveyor links

here is the "Beet Harvest Master," which is made by F. A. Standen and Sons, Ltd., Ely, Cambs. This machine is power take-off driven, and here again the topping is done one row ahead of the lifting. The latest development in the Standen harvester is the equipping of the conveyors with "Wavikleen" links. The illustration shows the design of these links; their purpose is to clean adhering soil and trash from the beet by a gentle rubbing action instead of by orthodox vibratory motion.

The ability to clean as well as convey the beet is a most important point in the design of complete harvesting machines. The shakers and elevators must remove as much of the soil and trash as possible without, of course, damaging the beet. The same requirement applies to the cleaner-loaders which are now being increasingly used by beet growers. There are times during the harvesting season when the factories cannot take immediately all the beet that are being lifted; the beet have then to be stored temporarily in a dump. Under these circumstances, a cleaner-loader is useful and time-saving when the grower is able to resume deliveries to the factory.

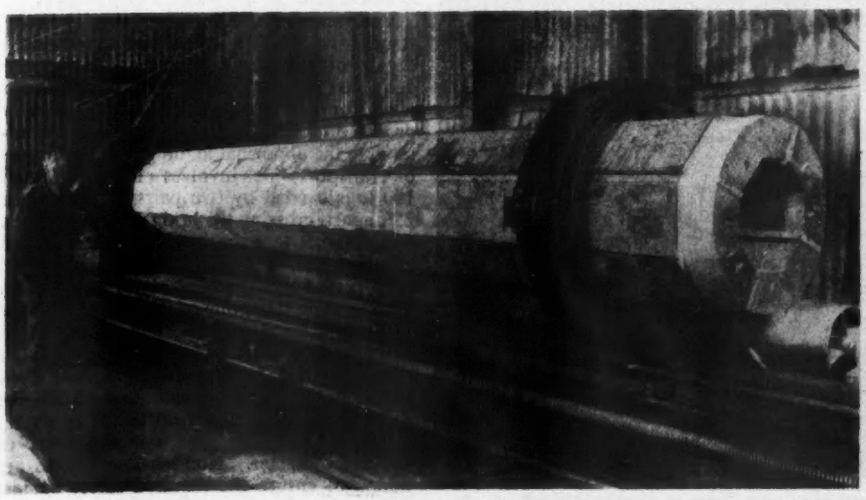
Immediately a load of beet reaches the factory, a sample is taken to determine the "top tare" (the quantity of tops left on the roots) and the "dirt tare." The disposal of leaves and soil presents a troublesome problem to all the processing factories. The nature of this problem was indicated to us recently at one of the factories where we were informed that the weed and stone traps incorporated in the initial beet washing channels had sometimes collected more than 30 tons of weeds and stones in a day during the height of the campaign. This aspect of mechanised harvesting was given special emphasis at the 1957 machinery demonstration organised by the British Sugar Corporation. One observation made by the control committee after that demonstration was that in most cases the performance of harvesting machines as judged by dirt tare, topping efficiency and root loss, combined with a reasonably high speed of operation, showed pronounced improvement over previous years. The most important feature, it was added, was the very successful operation of the majority of the harvesters working in a crop that had been mechanically thinned.

(To be continued)

Turning Large Wooden Spiral Columns

One of the outstanding features of the new high altar of St. Paul's Cathedral is the 54ft high, 26ft wide, baldachino or canopy beneath the coffered arch which separates the American Memorial Chapel from the eastern bay of the choir. The canopy is supported at each corner on a square pier flanked by one fluted and one spiral column. The following article describes how a lathe was adapted and a machining procedure developed for the turning of the four spiral columns in an engineering works. For these details we are indebted to Mr. R. Caswell, the works manager of the engineering firm of George Stow and Co., Ltd., of Slough, who was responsible for the work.

THE four spiral wooden columns forming part of the support for the new high altar canopy of St. Paul's Cathedral were made up of segments of carefully selected oak bonded together with "Aerolite 300" adhesive into the form of an octahedron. The turning of the columns so formed was entrusted to George Stow and Co., Ltd., of Slough, and one of them in the machined state is shown in one of the accompanying illustrations. The columns are each 16ft 6in long, 2ft 2in diameter at the base, and the entasis is slightly barrel-shaped, tapering to 1ft 9½in diameter at the top. Two of the columns have a right-hand and two a left-hand spiral, the pitch being 29 7/16in. A raised portion was left in the hollow of the spirals for carving a pattern of leaves up the whole length of the columns.



Built-up oak column set up in lathe for end facing and recessing operation

Wooden column, 16ft 6in high, 2ft 2in in diameter, for altar canopy support. The column has a 29in pitch spiral with a raised section left in the hollow of the spiral for carving purposes

As orthodox machining of spiral columns of this length and pitch was impossible, a Lang long-bed centre lathe was modified and special tooling improvised for the work. A special lead screw was made, using a 20ft length of 12in diameter tube, into each end of which was welded a 3in diameter spindle. This assembly was set up in the lathe and the spindles machined concentric with the tube. While it was in the lathe, the required pitch of spiral was carefully marked on the outside of the tube for 17ft of its length. Using an oxy-acetylene torch and electric welding plant, a ⅞in diameter bar was then heated, bent and tack welded around the tube, following carefully the developed line of the spiral form previously marked.

A chain sprocket was fitted to one of the spindles, which was mounted in bearings at the back of the lathe as near as possible to the saddle. A similar sprocket was fitted to the tail end of the lathe spindle and from it the lead screw was driven through a chain.

The back of the lathe saddle was fitted with a bracket which carried a phosphor bronze fork operable by a lever to engage and disengage on the lead screw bar welded to the tube. To reduce the severe thrust that would have otherwise been thrown on the weak side of the saddle and the lead screw, a counterbalance weight was suspended by a wire rope and, through a series of sheaves,

connected to the saddle. To hoist this weight and return the saddle to its starting position, a small motorised winch was used. The compound rest was removed from the saddle and in its place there was fitted a base plate carrying a high-speed motor driving a cutter head with two blades.

In the sequence of turning operations, the column was first swung up in the lathe with one end held in the chuck and the other supported from the lathe bed by a revolving steady. The column ends were then faced and recessed to accommodate steel centre plates. One of these plates had forty-eight 1¼in diameter holes equally spaced on a pitch circle diameter.

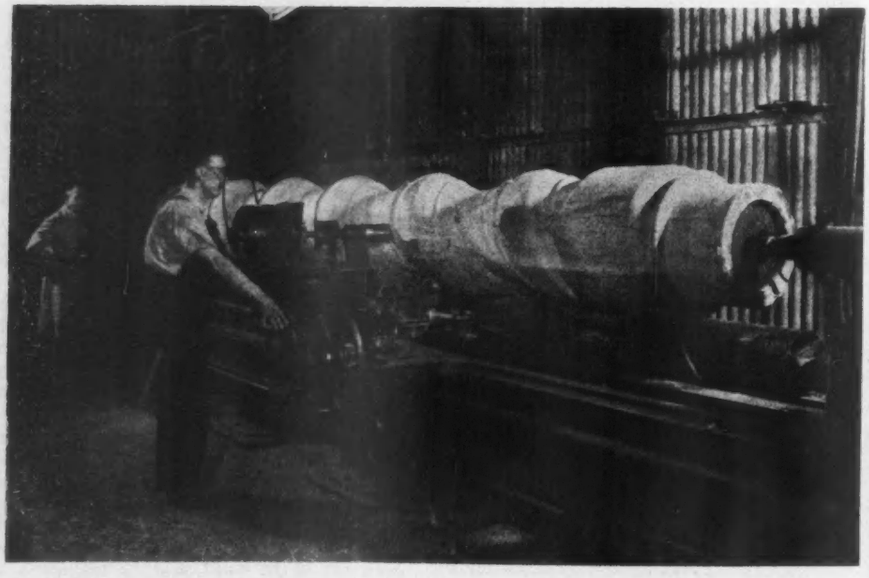
On another lathe the column was swung between centres and by the use of a taper attachment, the taper and barrel shape and the top and bottom moulding were machined.

The column was then returned to the lathe equipped with the improvised equipment, and on this lathe the spindle speed was set at 1½ r.p.m., its tailstock was set over to allow for the necessary taper and a spring-loaded peg mounted on the chuck. A horizontal start line was marked along the column for the length of one pitch. On this line there was then marked the centre line of pitch and each side of this line twenty-four ¾in equal divisions were marked. On a full-size drawing of the pitch there was then plotted the depth required to sink each cut at forty-eight positions along the profile of the spiral.

For the machining operation, the cutter was first set opposite the horizontal centre mark with the driving peg on the chuck disengaged and the column held stationary. The lathe was rotated until the fork engaged on to the improvised lead screw and the peg was then allowed to engage into one of the holes on the drive centre plate. The cutter head was started up, the lathe was set in motion and, at the same time, the cutter was plunged into the column as shown in the illustration below, where the cutter head and lead screw can clearly be seen. Since the column was rotating at only 1½ r.p.m. and the cutter speed was 4000ft per minute, the operator had very good control of the operation and was able to withdraw the cutter gently as he approached the end of the spiral required. The fork was then disengaged from the lead screw, the machine stopped, the saddle drawn back again to starting position, and this operation was repeated until it was necessary to move to one of the other start positions. In this way the spiral was progressively formed with varying depths of cut as each progressive indexing through the forty-eight positions on the centre plate was used.

After roughing out in this way, by the use of a template of the profile, and by swivelling the cutter head and changing the shape of the cutters, the necessary amount of wood was machined off to blend the spiral of the column with the template.

To cut the left-hand spirals, the driving sprocket was fitted to the second wheel on the lathe gear train to give a reversed rotation to the lead screw. The counterbalance weight rope was attached to the opposite side of the saddle, the winch rope changed over and the cutting operation was started from the chuck end of the lathe.



Spiral being machined on specially adapted lathe, using rotating cutter head on the saddle as it is traversed along bed by built-up lead screw at rear

"Wafer Slab" Bridge Decks

By P. W. ABELES

Here we reproduce abstracts from one of the papers presented at the third international congress on prestressing, held in Berlin last month. The "wafer slab" bridge deck has been developed by the Eastern Region of British Railways for application where construction depths must be reduced to a minimum. It is cast and prestressed in two stages, and embodies a more highly stressed skin. Tensile stresses are allowed in the concrete.

IN the course of electrification many arch bridges must be replaced by slab constructions so as to obtain sufficient headroom for the pantograph. These arch bridges are mostly replaced in two stages when the road traffic is limited to half the width. Propping of shuttering is impossible and consequently only a simply supported prefabricated construction can be considered. On the Eastern Region of British Railways a composite prestressed concrete deck (Fig. 1 (*a*)) has been employed for several hundred bridges since 1949 because of its economy and simplicity of erection. It consists of relatively light precast beams of inverted T shape with pretensioned wires and added high quality in-situ concrete which is carried by the simply supported precast beams placed by an ordinary road crane during a relatively short interval when the railway traffic is off peak. The composite slab then carries the additional load (live load and surfacing). Transverse reinforcement in the in-situ concrete ensures satisfactory load distribution and any prestressing at the site is avoided, as this would require a restriction of the traffic. This composite solid slab deck is suitable only for spans up to 60ft, whilst for longer spans box-shaped precast beams (Fig. 1 (*b*)) would be preferable.

These bridge decks have been designed as partially prestressed for a maximum permissible tensile stress at the bottom face of 650 lb per square inch under maximum live load. Extensive tests have proved that freedom from cracks is obtained for this condition even under dynamic loading, as the stress range due to live load is relatively small in this design. Complete co-operation between precast and added concrete up to failure load has been ascertained by tests, for the precast members have a roughened surface and, in addition, special grooves are provided at the top of the bottom flanges. This construction has been used also for railway underbridges; but tensile stresses were not permitted at the bottom face, in view of the heavy and repeated impact that may occur at rail joints, the effect of which has not yet been fully investigated; nevertheless, tensile stresses are allowed in the added concrete. Since 1949, performance tests have been carried out for one precast beam, selected at random, from each casting bed, and the loading has corresponded in most cases to a tensile stress of 750 lb per square inch. Cracks should not become visible at a load corresponding to a tensile stress of less than 900 lb per square inch provided that, by moist curing, the development of any shrinkage cracks had been avoided, prior to the transfer of prestress.

The deck construction (Fig. 1 (*a*)) has been standardised for ten types, and the required depths of prestressed beams and composite deck, as well as the number of tensioned wires, for each span are taken from a specially prepared table. The design is able to accommodate the abnormal loading of the Ministry of Transport which involves a heavy vehicle of 180 tons carried by two pairs of axles, each 25ft apart, crossing the bridge in a single line, and assumes that the maximum load carried by one beam, of 18in width, does not exceed 10·5 per cent of the total abnormal loading. Two loading tests, one of which was with the Ministry's heavy vehicle, have proved that the actual maximum load is less than the amount of 10·5 per cent which has been assumed. The pretensioned wires are of 0·2in diameter for the beams up to 2ft in depth, whilst the deeper types contain wires of 0·276in diameter. Non-tensioned wires are added to ensure the required safety against failure, based on a load factor of 1·5 related to the dead weight and 2·5 to the live load.

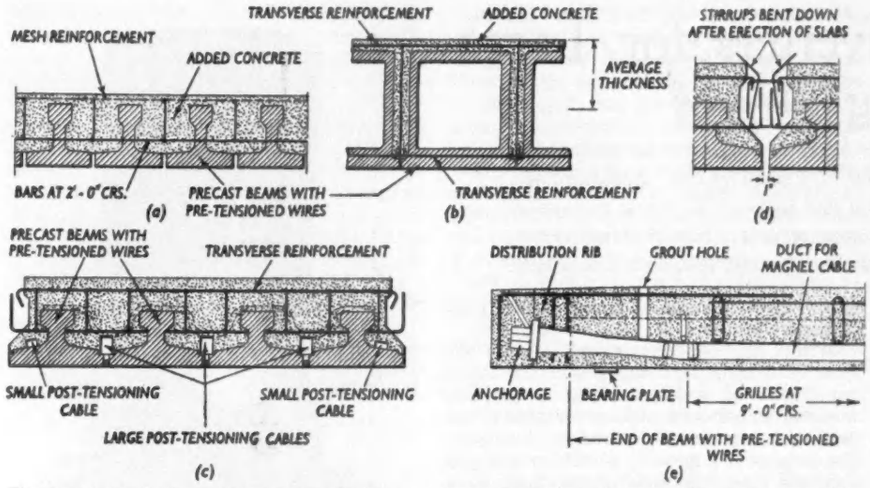


Fig. 1—(*a*) Composite partially prestressed deck; (*b*) box-shaped precast beams for spans over 60ft; (*c*) "wafer slabs" of four precast beams; (*d*) joint between "wafer slabs"; (*e*) cable anchorage detail

To obtain a very shallow construction, obviously a precast slab with bent-up cables seems to be preferable, since a composite deck must be somewhat deeper as a great part of the prestress is used to carry the in-situ concrete. However, economically the position is quite different. Though the composite deck requires approximately 20 per cent greater depth (i.e. 1·2 times the quantity of a precast slab), it will still be much cheaper, since only approximately one-third of it is precast prestressed, and the unit price of the in-situ concrete ordinary part is only about one-sixth of that of prestressed concrete, thus resulting in a unit price of $\frac{1}{3}(1\cdot2)+\frac{2}{3}(1\cdot2)(1/6)=0\cdot4+0\cdot13=0\cdot53$ of the cost of a precast prestressed slab, which would require for placing a crane of much greater carrying capacity. This is based on the assumption that the cost per cubic unit of prestressed concrete of each type erected is the same, which appears to be correct. However, the use of partial prestressing cancels out the disadvantage of greater depth required for a composite deck, referred to above. On this basis the economy is still further improved.

With the introduction of high-voltage traction current in 1956, it became imperative to reduce, in certain instances, the construction depth to the absolute minimum. The raising of approach roads is often impracticable and, even when possible, frequently more costly than the increase in price of the shallower bridge deck. For this purpose a composite construction, cast and prestressed in two stages, has been developed by the Eastern Region, in which the tensile skin is prestressed to a much higher extent than the remaining part. Standard bridge-deck beams are cast in a prestressing bed, preferably to the maximum permissible transfer stress of 3000 lb per square inch, but of a smaller depth than required for the deck indicated in Fig. 1 (*a*). In the latter case the maximum transfer stress is normally 2400 lb per square square inch for which a cube strength of 6000 lb per square inch is required at transfer, whereas in special cases a transfer stress up to 3000 lb per square inch is considered corresponding to a required cube strength of 7500 lb per square inch. In the "wafer" design, the additional concrete is cast when the first prestressed members are supported in such a way that they do not carry the self load. If desired, it is even possible to provide a counter-deflection by wedging. The second stage of prestressing is carried out at a time when an appreciable part of the losses has already taken place in the member first prestressed. Consequently, at the second stage of prestressing at which bent-up cables are provided, it is possible to prestress again to the maximum permissible stress of 3000 lb per square inch, after this previous stress value has been reduced by the losses associated with the first stage of prestressing and tensile stresses due to self load. Further creep losses will be less, since the first prestressed concrete has already matured to a great extent at the second prestressing, and the prestress in the added concrete at the second prestressing is relatively small with consequently limited creep.

This new deck, which is composed of precast slabs containing preferably three to four standard precast beams, as shown in Fig. 1 (*c*), is called the "wafer" deck. Obviously such a construction has not the advantage of great economy and ease of handling as is the case with the ordinary deck, but it is possible to reduce the depth to $L/30$ and even less for abnormal very heavy loading. With the deck as in Fig. 1 (*a*), the construction depth for this load amounts to $L/17$ to $L/22$ respectively for spans of 20ft to 50ft. A construction depth of $L/30$ is not outstanding for a slab cast *in situ* and prestressed in two directions. Similarly, shallower constructions may be obtained with continuous or cantilever slabs; but with the "wafer" deck the design has been based on the assumption that each beam of 18in width carries 10 per cent of the heavy abnormal loading, like the ordinary composite bridge deck (Fig. 1 (*a*)), and both without transverse prestressing. Satisfactory transverse distribution is obtained by the arrangement of the reinforcement at the joints of adjacent slabs, seen in Fig. 1 (*d*). The length of the precast bridge construction is somewhat greater than usual, since outside the bearings (which are preferably placed 9in from the ends of the first precast members), reinforced concrete ribs are provided inside the post-tensioning anchorages to ensure satisfactory transverse distribution of the second stage of prestressing within the entire slab (see Fig. 1 (*e*).

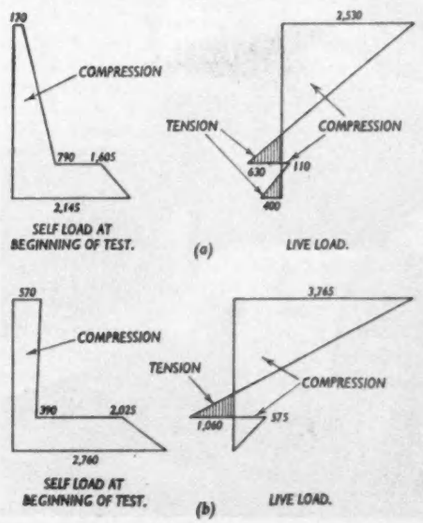


Fig. 2—Resulting stresses in pounds per square inch under self weight and live load for (*a*) slabs I and II, (*b*) slab III

With this type of bridge deck, the stress range of the live load is obviously considerably greater than with the composite deck in (Fig. 1 (*a*)), and this range may be as high as 2500 lb per square inch or more. It was, therefore, necessary to investigate this type of construction to ascertain the influence of dynamic load. For this purpose two types of slab were tested at Liège between November, 1956, and February, 1957, with very satisfactory results. In two slabs, the resulting stresses under self weight were in accordance with Fig. 2 (*a*), and in the third slab, in accordance with Fig. 2 (*b*). It is seen that, in the first case, the difference in stresses between the bottom faces of the skins and that of the added concretes was much less than in the second case (slab III). Consequently, under maximum live load only slightly increased tensile stresses occurred at these two points in slabs I and II (630 lb and 400 lb per square inch respectively), whereas a considerable tensile stress (1000 lb per square inch) occurred in slab III in the added concrete, when there was still no tension at the lower face of the skin of the slab. The tests have proved that, with such a large live load stress range as occurs in this type of construction, freedom from cracks is obtained if the maximum tensile stress at the outermost bottom skins of slabs I and II does not exceed 400 lb per square inch, whilst similar results are obtained in slab III, where there was no tensile stress at the bottom of the skin. Slab III, as manufactured, has the advantage that the magnitude of the second stage of prestress is reduced to a minimum, and the amount of pretensioning is increased to the maximum possible. This results in greater economy, since no special anchorages are required for pretensioning, although, on the other hand, the cost of post-tensioning is not reduced in direct proportion with the number of wires, unless it is possible to decrease the number of cables required. In any case, it is an advantage to reduce the amount of post-tensioning to a minimum and consequently a slab of type III (stresses as in Fig. 2 (*b*) seems preferable.

At the time of writing, this new design has been employed for two bridges in Essex, one at Clacton-on-Sea and the other at Colchester. A loading test has been carried out at the former.

The second bridge, at Ipswich Road, Colchester, is a skew bridge of 53ft span between the bearing plates. It was originally intended to cast six slabs, each containing three to four precast inverted T beams and weighing between 32 and 45 tons. However, a method of construction was put forward by the contractor, Wellerman Brothers, Sheffield, in which each half of the bridge was built above the existing arch and the self weight of the deck supported from the arch, before the latter was destroyed. This greatly simplified the construction, as handling such heavy units of a length up to 67ft would have been difficult.

Mercury-Arc Converters for Large Reversing Drives

A symposium on mercury-arc converters for large reversing drives was held recently at the Stafford Works of the English Electric Company, Ltd. Demonstrations were given of systems of controlling rolling mill motors (fed from a multi-anode mercury-arc converter), by reversal of armature or field; a similar system of controlling a mine winder by field reversal was also demonstrated, as described here.

ALTHOUGH the principles of using mercury-arc converters for reversing mill drives have been recognised for more than twenty-five years, the practical application has been limited in this country; a typical example is illustrated in Fig. 1. We were glad therefore of having an opportunity of attending a symposium arranged by the English Electric Company, Ltd., at its Stafford works. The object of the symposium was to demonstrate the possibilities of using mercury-arc converters for reversing drives, in rolling mills and in mine winder drives.

Since 1932, when the English Electric Company first demonstrated the use of mercury-arc converters for reversing drives, there have been no fundamental changes of principles, but there have been major changes in the design of the converter and new components, such as magnetic amplifiers, have made their appearance and become firmly established in control and servo systems.

One of the main requirements for large reversing drives is that the power conversion equipment should be capable of accepting and returning to the a.c. system any power generated by the motor when braking. It is economical to combine the processes of rectification and inversion in the same equipment. The term "mercury-arc converter," as adopted by the I.E.C., is, therefore, preferred to "mercury-arc rectifier."

The Converter

The converter chosen for the works demonstrations was a multi-anode equipment in a tank, developed for industrial drives in which the working peak currents are much larger than the rated r.m.s. and average currents. It incorporates recent developments to give improved cooling, increased arc path cross section (and, therefore, reduced arc drop), and reliable operation under heavy peak currents when cold.

Briefly, the converter (Fig. 2) is in the form of a cylindrical tank, with six anode arms each of which contains a graphite anode mounted on a steel arm welded to the steel end cap of the porcelain insulator. The cathode is a mercury pool in a steel cup insulated from the base of the tank by a porcelain ring. Jet ignition is used to produce the electron emitting cathode spot: a solenoid-operated plunger forces mercury up a tube below the cathode pool and causes a jet of mercury to impinge on the ignition anode. The spot is then maintained by two excitation anodes which are fitted in the side of the tank and are excited by a small single-phase transformer. Each anode is equipped with a control grid and a deionising grid.

Porcelain is used in all the anode and cathode seal assemblies, the external surface being shedded and glazed for service in polluted atmospheres, while the internal surfaces are unglazed because the rougher surface is less easily wetted by mercury. Vacuum-tight sealing is obtained by fusing nickel-cobalt alloy steel rings to the ends of the porcelain cylinders, glass being used as the bonding medium. All these component materials in the seals are matched for coefficients of expansion over a wide temperature range. Cooling is assisted by a fan blowing air upwards over radial cooling fins on the outside of the tank, which is surrounded by a cylindrical shroud (Fig. 2.)

There is a choice of three methods of using mercury-arc converters for a large reversing drive: cross-connected converters, or armature reversal, or field reversal.

The first method, that of cross connection, requires two sets of converter equipment, permanently connected to the machine bars; one acts as the rectifier for forward rotation and as an inverter for braking when running in reverse rotation; the other performs the same function for contra-rotations. This circuit avoids the reversal of either motor flux or motor armature. There is thus negligible "dead" or "lost" time at the point of changeover from motoring to braking. Such an arrangement is necessary when rapid and continuous speed control of high-inertia drives are wanted. Usually, it is no more expensive in first cost than an equivalent motor generator set and, of course, retains the efficiency advantage of converters.

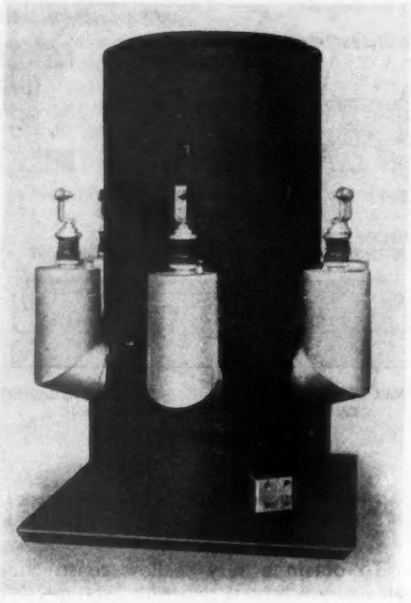


Fig. 2—Typical industrial multi-anode steel tank rectifier

With the somewhat less exacting requirements of reversing mills and some winders where a short period of "dead" time (say, 0·3 second or longer) is tolerable, some saving in first cost can be accomplished by employing the same converter for both motoring and braking duty. Because the mercury-arc converter can pass current in one direction only it becomes necessary to reverse the motor polarity when changing from motoring to braking. It can be done by reversing either the armature connections or the motor field.

For armature reversal, at the instant when it is desired to initiate braking, the grid impulses are phased back to the position for maximum inverter back e.m.f. (Fig. 3);

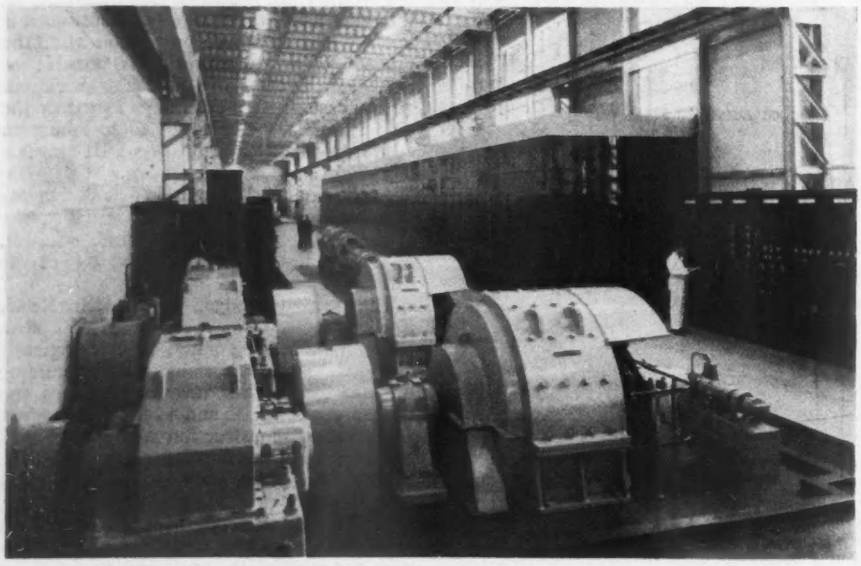


Fig. 1—Motor room of modern hot strip mill showing rectifier equipment for supplying one of the roughing and all the finishing mill motors

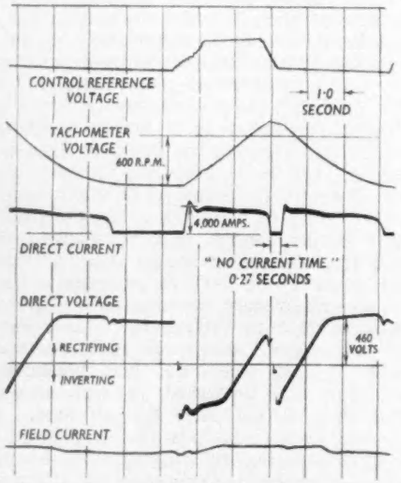


Fig. 3—1500 h.p. reversing drive. Mercury-arc converter with armature reversal

this interrupts the motor current and the armature connections are then reversed by means of the reversing switch. When reversal is complete, the phase position of the converter grid impulses is advanced to reduce the inverter back e.m.f. to a suitable level to allow braking current to flow. By continuous advance of the grid phase angle, the motor will come to rest and, if the phase advancing be continued, can be brought up to speed in the reverse direction. This system of reversal is being used on the rolling mill drives now in course of construction in Stafford works.

For field reversal, the procedure is similar except that, if desired, the inverter e.m.f. can be reduced to allow braking current to flow as soon as the machine e.m.f. has reversed (Fig. 4). The inverter back e.m.f.

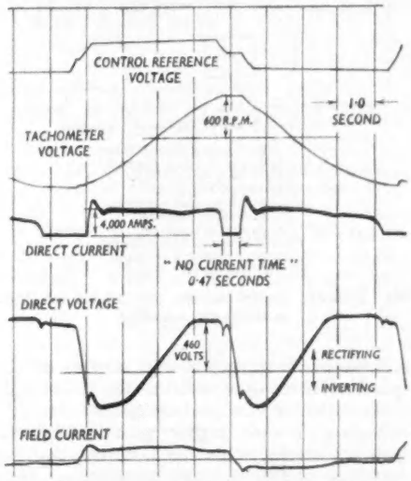


Fig. 4—1500 h.p. reversing drive (solid motor frame). Mercury-arc converter with field reversal

is controlled at the level which provides the requisite braking current until the motor is at rest. Reverse rotation of the motor is obtained by further advance of the grid phase position. Operationally the main difference between the two methods is that armature reversal can be made slightly faster than field reversal. The value of this time advantage depends upon the application ; for example, it may be of greater interest in steel mills than to some colliery winders.

Demonstrations of both armature reversal and field reversal were given at Stafford during our visit.

Armature reversal involves the use of a relatively heavy current reversing switch which, however, does not have to break current. It must, of course, be capable of withstanding frequent operation.

With field reversal there is associated the problem of reversing a small current in a highly inductive circuit and of building up that current in the reverse direction as quickly as possible. The use of laminated frame d.c. machines assists materially in reducing the flux reversal time.

Method of Simulating Rolling Mill Drive

In a typical hot reversing mill the base-to-base reversal time varies between one and two seconds, the top-to-top time being between three and six seconds depending on the shunt speed range of the motor. The current absorbed by inertia is usually limited to between 50 and 100 per cent of full load current so that rolling can be done between speed changes.

No actual rolling took place during the demonstrations at the Stafford works and accordingly the full capabilities of the machines were used for acceleration and deceleration. In choosing suitable machine sets for these demonstrations the criteria were that the time constants should be representative and that the machines should be able to withstand reasonable armature voltages and currents.

The rectifier test set chosen for the demonstations has two d.c. machines in tandem on each side of a synchronous machine which can be used either as a motor or alternator. The working conditions chosen are a base speed of 300 r.p.m., a top speed of 600 r.p.m. to be obtained by field weakening, and a voltage of 460V. This five-machine set is capable of handling 4000A on acceleration and of changing speed at a rate of nearly 500 r.p.m. per second. The four d.c. machines have solid frames, so that the field-weakening and field-strengthening characteristics are typical of machines commonly used in rolling mill practice. The field response times are as fast as possible within the design limits of the existing machines. The four d.c. machines are connected in series-parallel.

Most of the equipment used in the demonstration is normally used for loading rectifiers and converters on test. The incoming a.c. supply is at 6·6kV from the Midland Electricity Board. The rectifier transformer is connected delta/double star. Three standard pumpless, steel tank mercury-arc rectifiers in cubicles constitute the converter, the nominal rating of which is 2250A, 1035W at 460V, with a peak current capacity of about 4500A. The grid control equipment is of the impulse reactor type to give smooth and continuous control from full rectification to full inversion.

Reversal by Armature Switching

When a speed change involves braking and reversal the switch is operated once only, to cause braking reversal and subsequent acceleration in this reverse direction. However, to produce a lower speed in the same direction of rotation the switch must be operated twice : first a reversal to cause braking ; and secondly a return to the original position to restore power running in the original direction.

Two armature reversing switches have been developed. Each consists of a set of four electro-pneumatically-operated contactors similar to those used on main line electric locomotives. These four contactors are mounted on a single framework and are interlocked to ensure correct operation. The reversal time of the switch is less than 0·125 second. A life of at least 5,000,000 switching operations with major attention is expected by the manufacturer, and that would correspond to two years' normal use between overhauls. All contacts can be changed from the front with simple tools.

The smaller switch which was the one used for the demonstration is stated to be suitable for use with reversing motors of about 1500A continuous rating at 750V, but with the ability to handle frequent peaks of 4000A. The larger switch is designed for a service voltage of 1200A and a current-carrying capacity of 5000A continuously, with peaks of 12,000A–15,000A. These figures correspond to a motor rating of 5000 h.p. to 6000 h.p. and two such switches could be used for a 10,000 h.p. to 12,000 h.p. twin drive. Since the contactors in both equipments are designed to break substantial currents they can be regarded as line contactors as well as simple reversing switches.

Control Scheme for Armature Switching Reversal.—The scheme (Fig. 5) is one of speed control rather than voltage control. The operator's controller provides reference signals up to ±100V, which is compared with the voltage of a tacho-generator driven by the main motor. Any difference between the actual and desired speeds operates the grid control gear through a magnetic amplifier and thus adjusts the converter voltage to restore the speed to the desired value.

If, for example, the controller is moved from forward to reverse the speed-error signal becomes negative, which blocks the grids and stops the main current : when this current ceases another magnetic amplifier causes reversal of the switch. Auxiliary contacts on this switch then reconnect the error circuit, whereupon the converter begins to reduce its inversion voltage. Then, when the converter voltage matches the motor voltage, inversion current flows again and the motor is braked regeneratively and goes smoothly through standstill to reversal as the converter goes through again to rectification.

A simple current-limit circuit keeps the current in the main circuit below a predetermined safe maximum value. The main current is measured by a d.c. transformer and the output goes through a current-limit magnetic amplifier to the grid control magnetic amplifier.

A useful refinement in interlocking is that of making the switch magnetic amplifier confirm that the main current is virtually zero, which means that the switch does not have to break current. Switch maintenance is, therefore, reduced and there is less shock to the motor and the converter.

Through a conventional current control system the motor field system provides what is basically full field excitation.

If the controller demands a higher speed than that corresponding to the normal voltage of the converter, it tries to produce excess voltage. This attempt is detected and is used to cause weakening of the motor field until the motor speed rises to the required value.

Braking from such a weak-field speed requires field strengthening to maintain maximum braking torque. During this process the same excess current circuit functions to prevent the motor from generating too high a voltage as it slows down because of field strengthening. It also restrains the converter from trying to produce too high an inverter voltage.

In a reversal from top speed to top speed switch reversal is followed by field strengthening at full inverter voltage, then by changing to rectification and, finally, by field weakening.

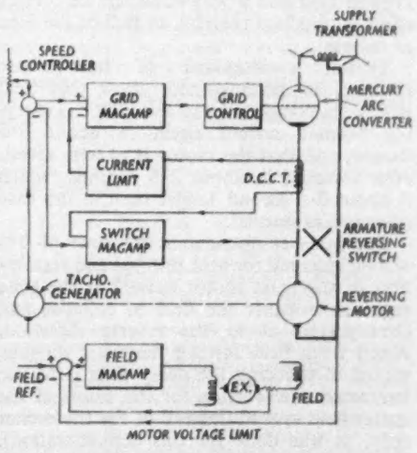


Fig. 5—Basic control scheme for mercury-arc-converter-fed reversing mill motor

Demonstration of Armature Reversal Scheme.—To demonstrate the system a reversal from base speed to base speed (300 to—300 r.p.m.) was carried out using power braking and one switch reversal.

An oscillogram of a similar run shows that, from the start of controller movement the switch reverses and current is flowing again in 0·19 second. Deceleration to zero speed and subsequent acceleration are under current-limit control. The set goes through standstill condition smoothly and reversal is complete 1·96 seconds after the start of controller movement. Of this reversal time of 1·96 seconds only about 10 per cent (0·19 second) is occupied with control events peculiar to this control scheme, while the remaining 90 per cent (1·77 seconds) is purely a function of the current capabilities of the machines. With suitable machine characteristics a total time of 1·5 seconds, or even less, would seem to be practicable.

The switch takes 117 milliseconds from first release of the closed magnet valves until the main d.c. circuit is completed in the opposite direction. The rest of the 190 milliseconds is absorbed by the remaining parts of the circuit involved in the reversing operation—grid magnetic amplifier and grid control, and switch magnetic amplifier and relay.

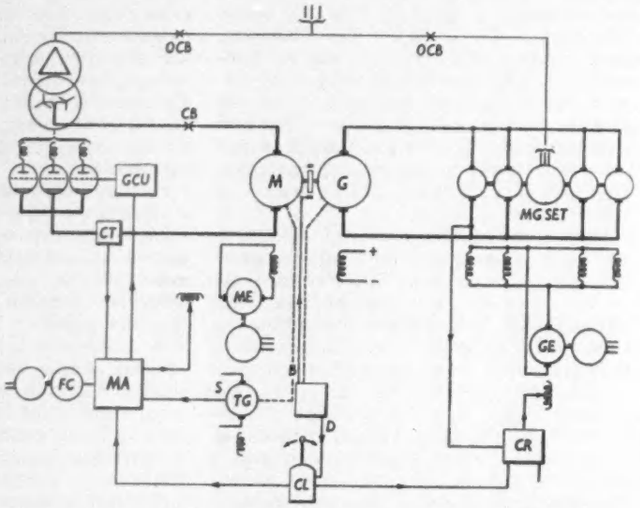


Fig. 6—Block schematic diagram for converter-fed winder load simulation equipment

Field Reversal Scheme

The equipment for field reversal is identical with that described for armature reversal. The armature switch is locked in one position. Now the motor field exciter has to provide field reversal as well as field weakening and strengthening. Field reversal is effected under the same conditions as armature switch reversal already discribed. The switch magnetic amplifier determines the point when the exciter must reverse, and the principles of the whole operation are generally the same as for armature reversal. The maximum voltage of the exciter (which is laminated for fast response) is limited to about eight times that required for maintaining full field and a very considerable forcing effect is obtained thereby, to reduce the time of reversal.

Typical oscillograms of base-to-base reversal, as demonstrated, show that field reversal is completed and the motor is carrying normal current again in about 0·5 second, and that the motor is at base speed, after reversal, in about 2·5 seconds, which is about 0·5 second longer than in the case of armature reversal.

The main component in the time of 0·5 second required for field reversal and restoration of the main motor current is the time required to cause the field to collapse and then restore it in the reverse direction. Apart from field forcing the most obvious means of reducing the delay time is to use laminated construction for the whole of the motor field system (instead of for the exciter only, as was done for this demonstration). Investigations made by the company indicate that the time interval of 0·5 second could be reduced by approximately 25 per cent.

Armature switching gives faster reversal than field switching and the control is somewhat easier, but the saving of 0·2 to 0·4 second is hardly decisive in overall reversal times of 1 to 5 seconds. The extra cost of reducing the time of field reversal may exceed the extra cost of the switch in the armature reversal system. Both schemes have a performance very similar to that of conventional Ward-Leonard control.

Field Reversal of Mine Winders

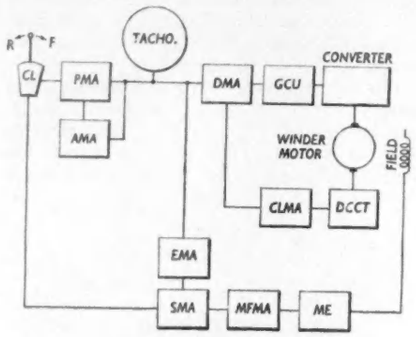
The equipment required for field reversal of a converter-fed mine-winder-motor is shown in the left-hand half of Fig. 6. It consists of a supply transformer, converters, winder motor (*M*), high-speed circuit breaker, grid control unit (*GCU*) motor field exciter, (*ME*), magnetic amplifier control cubicles (*MA*), a frequency-changer (*FC*) to provide 400 c/s supply to the magnetic amplifiers, a tachometer generator driven from the motor winder, giving the speed feedback signal (*S*) and the driver's control lever (*CL*).

To simulate winder operating conditions for the demonstration use was made of the following equipment (symbolised in the right-hand half of Fig. 6) : a constant-field-excited generator *G* driven by the winder motor and connected to the four paralleled d.c. generators of the m.g. set in the rectifier test department described above. The generator field exciter *GE* excites the four d.c. generators at a value determined in magnitude and direction by the current regulator *CR* which is supplying the field of the exciter *GE*.

With the motor of the test m.g. set synchronised on the busbars and a current reference signal applied the current regulator will maintain the current in the generator loop at the value decided by the reference signal. The current may be of constant value equivalent to the load torque for a friction winder or a balanced drum winder and can act in either direction, to oppose the winder motor rotation for a raising load or to assist it for a lowering load. The current can also be varied throughout the wind to represent the changing load torque of an unbalanced drum winder. The arrangement is a form of back-to-back system and the only power taken from the supply is that needed to provide the losses. Both these basic forms of duty cycle were demonstrated.

A mechanical drive from the generator operates limit switch contacts which reduce the speed reference to a creep speed value when the point for retardation is reached and they operate the brake soon after the creep speed value has been reached by the winder motor.

In Fig. 7 we show the magnetic amplifier control in more detail. The main difference between this system and the block diagram of the rolling mill magamp control is the inclusion of a rate of change control on the speed reference to set acceleration and retardation rates for winder duty cycles. Another difference is that higher gain is required from the system to give the necessary decking accuracy under all load conditions. For armature reversal the sequencing magnetic amplifier would feed into an appropriate control unit operating the reversing switch.



CL—Driver's control lever.
AMA—Acceleration magamp.
GCU—Grid-control unit.
EMA—Error magamp.
MFMA—Motor field magamp.
PMA—Pattern magamp.
DMA—Driver magamp.
CLMA—Current limit magamp.
SMA—Sequencing magamp.
ME—Motor field exciter.

Fig. 7—Basic control scheme for winder fed from mercury-arc converter

The machine representing the winder in the demonstration was one of two constituting a motor-generator set used by the company for general development work on rotating machines. The two machines are identical and are typical of those encountered in rolling mill and winding applications. Each machine has a nominal output of 1600W, 500V, 3000A at 750 r.p.m., with a peak rating of 9600A. Normally these machines are naturally ventilated but, for the demonstration which involved low speed running and standstill periods, forced ventilation has been added.

One machine is of conventional construction with a rolled steel yoke and laminated main poles and commutating poles. The other machine (the one supplied from the rectifiers in the demonstration) has a laminated frame to reduce the eddy currents which tend to slow down the response of the main flux and commutating pole flux in relation to their respective currents. The laminated frame not only gives improved field response but it also gives improved commutation under transient conditions, for example at the end of the acceleration period or the start of retardation where rapid armature current changes take place.

Field forcing is applied. At the start of field reversal the excitation is five times normal and it is reduced to normal when the current reaches its normal value.

The torque required to accelerate a balanced drum winder is usually about 1 to 1·25 times F.L.T., with a starting torque of about 2 to 2·25 F.L.T. The duty cycle demonstrated gave an approximate representation of a winder of 900 h.p. r.m.s.

For a friction winder the torque to accelerate is about 0·5 to 0·75 F.L.T., with a start-

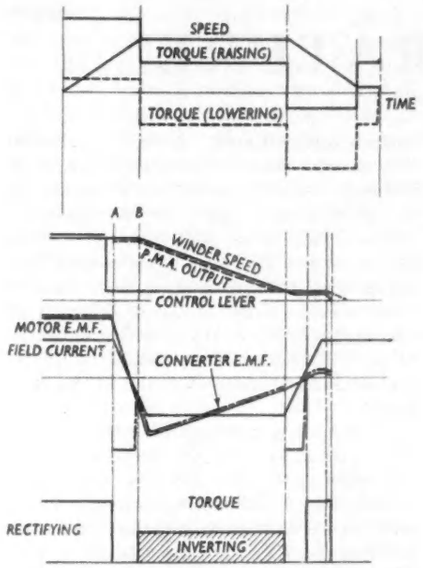


Fig. 8—Duty cycle diagram for balanced drum winder motor fed from mercury-arc converter

ing peak of about 1·5 to 1·75 F.L.T. Accordingly the demonstration given corresponded to a friction winder of about 1500 h.p. r.m.s. rating.

In Fig. 8 we show the first duty cycle demonstrated. It is typical of a balanced drum winder and shows positive torque required under all loading conditions for acceleration at the set rate to the desired speed, positive or negative torque during the constant speed periods of the wind, and negative torque under all loading conditions for retardation at the set rate down to creep speed. The full variation of torque demand on the winder motor is shown by full and dotted lines in the top portion of the diagram. The lower portion of the diagram shows, on an extended time scale, the action which takes place when the torque demand on the motor swings from positive to negative at the point for retardation. At this point the reference from the driver's control lever into the pattern magnetic amplifier (*PMA*) is reduced to a creep speed value either by the driver or by cam operated contacts as demonstrated, and the *PMA* output starts to fall at the set rate. At the point A (Fig. 8) the reference from the *PMA* has fallen below the winder speed thus producing a negative error, which immediately results in the converter e.m.f. swinging to its maximum negative (inverting) value, causing cut-off of the converter current, and changeover of the field. As the motor field changes in direction and so does the motor e.m.f. the speed error is switched so that it again appears positive to the system and the converter e.m.f. starts to rise, becoming less negative until it is again positive to the motor e.m.f. at B and current begins to flow with the converter now inverting. This condition is maintained throughout the retardation period until creep speed is reached when similar action again takes place for the converter to return to the rectifying mode of operation for creep into " bank."

With the smaller inertia torque to F.L.T. ratio associated with friction winders the boundaries of the torque demand on the winder motor are as shown in Fig. 9. In this case, as was demonstrated, it is possible in the extremes to have a complete wind with positive torque (rectifying) or with negative torque (inverting) and it is the start of the latter which is of particular interest and shown on the extended time scale in the lower half of the diagram. Here the case is shown where the driver has built up torque before releasing the brake. As soon as the control lever has been thrown over to the full speed position and the brake released the winder speed has almost immediately risen above the *PMA* output giving negative error and changeover to the inverting condition on the converter.

An unbalanced drum winder with torque demand varying throughout the wind, particularly as obtained on the deep shaft winders of the South African Goldfields is exemplified in Fig. 10, where on an exaggerated scale we show how, with the changing load, the winder speed gradually approaches the speed reference in value, finally resulting in a negative speed error with the resultant changeover as described for earlier duty cycles.

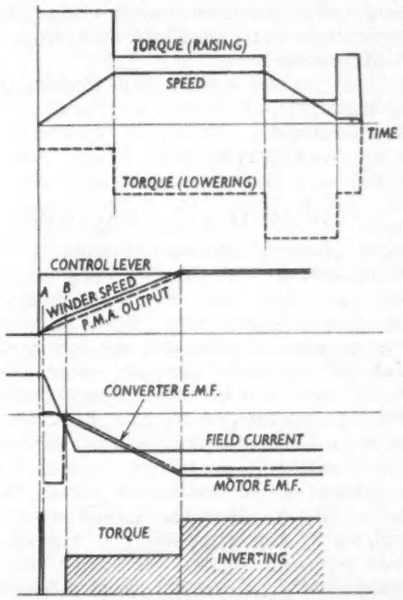


Fig. 9—Duty cycle diagram for friction winder motor fed from mercury-arc converter

In addition to the demonstration of normal duty cycles as outlined above the company showed the ability of the electrical control to give the low speeds necessary for rope and shaft inspection, rope changing and other special duties where such control is required.

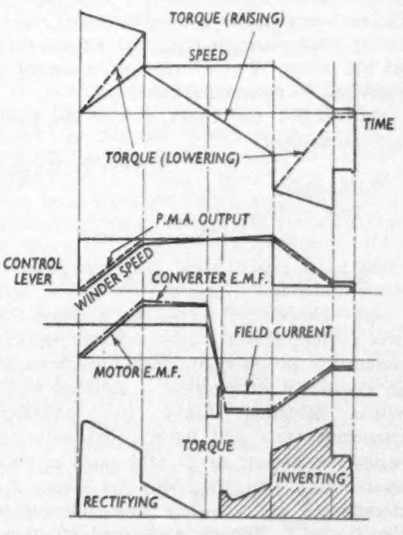


Fig. 10—Duty cycle diagram for unbalanced drum winder motor fed from mercury-arc converter

Technical Reports

Properties of Wrought and Cast Aluminium and Magnesium Alloys at Room and Elevated Temperatures. H.M. Stationery Office. Price 22s. 6d.—The report gives the results of tests carried out for the Ministry of Supply by Bristol Aero-Engines, Ltd. Fatigue, tensile, expansion and conductivity tests were performed at atmospheric and elevated temperatures up to 350 deg. Cent., while the density and hardness tests were carried out at atmospheric temperature only, the latter tests being made after soaking in the unstressed condition at elevated temperatures for up to 1000 hours. Eighteen wrought and twenty-eight sand cast alloys were used and for fatigue tests standard or notched test pieces were used for the wrought alloys and standard or fillet test pieces for the other materials. The tests were made with a reversed bending stress superimposed on a static stress. Fatigue tests on wrought alloys at atmospheric temperature were carried out using test pieces soaked in stressed or unstressed condition for 1000 hours at various elevated temperatures. Creep tests were made on wrought alloys at elevated temperatures and metallographic tests made both before and after the creep and fatigue tests.

The tests showed that the material having the best fatigue properties did not necessarily have good creep and tensile properties at the same temperature. Therefore, to use elevated temperature data it is essential to know operating temperatures and whether the major stresses will produce fatigue, creep or tensile failure. Furthermore, the coefficient of expansion, thermal conductivity, density and bearing properties have to be allowed for. To help in solving the problems set by combined fatigue and creep stresses in components the N.P.L./Bristol combined stress machine was designed, which facilitates testing with a reversed bending stress superimposed on a static tensile and/or static bending stress. The machine determines the effect of creep on fatigue properties, but not creep properties. The results are considered more useful for design purposes where fatigue and creep are combined. Published data is set out in tabular form and compared with the results from the present tests and fairly close agreement was observed.

Flow in the Laminar Boundary Layer near Separation. By B. S. Stratford, Ph.D., with an appendix by Dr. G. E. Gadd, of the Aerodynamics Division, N.P.L. Communicated by Professor H. B. Squire. Reports and Memoranda No. 3002. H.M. Stationery Office. Price 8s.—A simple formula is derived for the separation of the laminar boundary layer. The method of derivation and a key test suggest that it should be reasonably accurate and of general application, including particularly the range of sharp pressure gradients and small pressure rises to separation.

In addition, a partially new exact solution is found for the boundary-layer equations of motion ; also the pressure distribution is obtained for continuously zero skin friction, this pressure distribution being expected to attain any given pressure rise in the shortest distance possible for a given laminar boundary layer provided that there is neither transition nor boundary-layer control.

Books of Reference

British Standards 1958 *Yearbook.* British Standards Institution, 2, Park Street, London, W.1. Price 15s.—More than 3000 British Standards have been issued since the foundation of the British Standards Institution in 1901, and this edition of the year book includes a numerical list, together with brief descriptions, of all standards current to the end of 1957. Apart from these, there are details of Codes of Practice, Handbooks and other B.S.I. data ; lists of publications of the various international bodies dealing with standardisation ; locations of reference sets of standards, both in the United Kingdom and overseas ; services for U.K. manufacturers exporting to Canada, and information concerning the aims, objects and membership of the B.S.I., together with a list of chief officials. This yearbook will prove of value to all who use British Standards, and require a ready means of obtaining information concerning them and standardisation in general.

Explanatory Handbook on the British Standard Code of Practice for Reinforced Concrete (No. 114 1957). By W. L. Scott, M.I.C.E., W. H. Glanville, D.Sc., M.I.C.E.,and F. G. Thomas, M.I.C.E. Concrete Publications, Ltd., 14, Dartmouth Street,Westminster, London, S.W.1. Price 12s. 6d.—The new edition of this well-known handbook retains the general arrangement of the previous editions, but considerable modifications have been made to explain extensive revisions made to the code issued in 1957. The revised code of practice is included in its entirety, and the authors give a clear and authoritative interpretation of its requirements. For the first time the code gives recommendations for the design of reinforced concrete by the load factor method and charts for design by this method are included.

LETTERS AND LITERATURE

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

BEAMA AND SCREW THREAD PRACTICE

SIR,—Perhaps your readers might be interested in one Canadian's personal reaction to the "Shorter Report" in your issue of March 14, 1958, on the British Electrical and Allied Manufacturers' Association's guidance booklet on *Standard Screw Thread Practice in British Engineering and the Use of Unified Screw Threads*. All will agree that the broadest possible standardisation of screw threads is desirable. The obstacles to achieving such a goal are so numerous and complex that it does not appear likely that complete standardisation will occur in the foreseeable future. However, the inability to achieve complete standardisation should not be allowed to deter us from attempts to maintain a progressive programme to cut down variety. Everyone, of course, is in favour of reducing costly variety, as long as it is the other fellow's variant. This negative reaction provides a serious impediment to progressive standardisation.

I hope your readers will accept as an honestly held, and not unfounded, opinion that the BEAMA's booklet does not give impartial coverage to the arguments in favour of strong support for the Unified Thread. Had it done so it would have pointed out that the greater part of the world is overwhelmingly committeed to a 60 deg. thread and that there is no prospect that a 55 deg. or a 47½ deg. thread will ever be adopted internationally for standard fastenings; that the International Standards Organization has adopted the ISO profile which is identical with the Unified profile; that now over 99 per cent of the threads manufactured in North America are either Unified or interchangeable with Unified and that not one North American store in 100,000 carries either Whitworth or BA standard replacement fastenings. This situation, in the writer's opinion more than any other single factor has impeded the sale of United Kingdom mechanical products in the North American market. Competitors invariably make maximum use of this argument to good effect. U.K. automotive manufacturers are taking a realistic approach and their increased usage of Unified thread fastenings has materially aided their North American sales.

Much has been done recently and with some success to encourage greater U.K. sales here. Canada is, geographically, a huge country, richly endowed with natural resources and still in its infancy. For many decades it will provide a ready market for industrial electrical and allied equipment. If U.K. suppliers intend to compete for a share of this business or, indeed, any North American business, it is suggested they will have a much better chance on the basis of a 60 deg. Unified thread. Also, although it is still a controversial issue, the same condition, I believe, will apply to India. Early in the year I was advised that their Sectional Committee decided to adopt the Unified Coarse and the Unified Fine threads as the Indian standard. A review of the situation on the basis of an unprejudiced evaluation of all factors, would appear to indicate that a "stand pat" attitude is fraught with the danger of hindering or even shrinking U.K. participation in the so-called "hard money" markets of the world.

JOHN H. MCKAY

Ottawa,
Canada,
April 23, 1958.

E-STAR SYSTEM OF FRACTIONS

SIR,—British engineering practice is so firmly wedded to the system of using eighths and sixty-fourth-parts in expressing fractional sizes (along with all the tongue-twisting complications that this involves), that the Continental (decimal) system, has hardly had a look-in, although undoubtedly the more elegant and accurate of the two. There is, however, a third system available, closely parallel to our own, yet with all the advantages of the Continental, namely the E-Star system. Here the decimal point is replaced by a star, the first digit following then represents eighths, the second sixty-fourths and so on. Such things as twist-drill sizes will fall into place almost automatically. For instance, whilst dead quarter-inch is represented by *2in, drill sizes $^{1}/_{64}$in below or above are denoted by *17in and *21in respectively. Awkward tongue-twisting sizes like $^{11}/_{32}$nds and $^{27}/_{64}$ths are now replaced by *32 and *33 (E-Star 32 and E-Star 33) respectively, and comparison between them becomes immediate and automatic. The terms eighth, quarter, &c., can still be retained, and used quite happily along with the more precise "clearance" and "tapping" sizes (which will almost invariably be denoted by two E-Star digits as above). Conversion of E-Star sizes to their decimal equivalent and vice-versa can be made at a glance from a Conversion Scale (which could be permanently displayed in the workshop). This has E-Star sizes (0 to 1) boldly marked on one edge, and decimal sizes on the other. When three-digit accuracy is required, the conversion rule is:

Add 0·002 for every E-Star 001 (very approximately).

AUBREY S. RYNESS

Nottingham,
May 6, 1958.

RAILWAYS INTO ROADWAYS

SIR,—Despite your editorial of April 25, it is evident that the opponents of railway conversion are still considering the scheme on an emotional rather than a rational basis. While Brigadier Lloyd has produced numerous facts and figures, the anti-conversionists appear to be very short of such ammunition. In the May 23 issue, for example, I noticed only two statistics in the "anti" letters and one of those was a quotation from an earlier letter from Brigadier Lloyd. It was also evident that at least two of your correspondents in this issue had either not read or had failed to understand *Twilight of the Railways*. People who attack this scheme without having studied this very readable and low-priced work are hardly being fair to themselves. Indeed, one of the big dangers to railway conversion is probably that too many people will rush into a condemnation of the plan and then find it difficult to eat their words.

While I cannot attempt the sort of survey which you suggested in your editorial is the responsibility of the Railway Conversion League, may I mention a few points which occurred to me while waiting for a late train at Birmingham's New Street Station? Less than 250 passenger trains are shown as departing on a normal week-day; allowing ten road vehicles per train—surely adequate when one remembers the national average of ninety passengers per train—it would appear that 2500 bus departures per day would suffice for passenger traffic from this busy station which is currently regarded by B.R. as a bottleneck. The much-publicised new Brussels roads are stated (*International Road Safety and Traffic Review*, Winter, 1958, edition, page 8) to have a capacity of 1300 vehicles per hour per lane of only 10ft 6in, with a continuous flow and 10 per cent of commercial vehicles. Even with an interrupted flow, cycle 50/50, 10 per cent right and 10 per cent left-hand turns, the capacity is 400 to 450 vehicles per hour. As I was not equipped to carry out measurements, I must leave it to others to calculate the number of traffic lanes which would be available at the approaches to New Street Station; I submit, however, that the above figures show that, provided there is room for one lane in each direction, there would be adequate road space and some remaining for other traffic. A further comparison might be made, using Dr. Glanville's figures: rural trunk roads, 6700 vehicles per day; trunk roads in built-up areas, 6200 per day. It is perhaps opportune here to repeat his description of rural trunk and Class I roads: "1 per cent have dual carriageways or single carriageways at least 40ft wide, 10 per cent are less than 40ft but at least 30ft wide, 67 per cent are less than 30ft but at least 20ft, and 22 per cent are less than 22ft wide." In view of these figures, can it seriously be claimed that a converted New Street Station would experience congestion troubles?

At considerable expenditure of time, the members of the Railway Conversion League might carry on from here and make the detailed survey you require. But what would it prove? Would it mean an end to opposition to conversion? The answer is, of course, negative. The case would doubtless be strengthened but the League would still be faced with the fact that conversion is not mainly an engineering problem, nor is it purely a matter of road versus rail. What is needed is a full-scale, impartial inquiry—mainly in public but with power to hear evidence of a secret nature in private if

necessary—to study the future internal transport needs of the country. I suggest that this inquiry must be official for, to be of any real value, it must have power to take evidence from Government departments (the Treasury, Ministries of Transport, Labour and Power are obvious examples) and, for example, from nuclear research scientists (probably in secret) on the potentialities of new sources of energy for transport. M.I.5 might also be called to comment on the strategic value of electrified railways, in view of the political sympathies of the leadership of a certain trade union ! Evidence should also be taken from airline corporations, the Inland Waterways Association, &c., and all interested parties should be able to examine the evidence of the others.

At present you are, Sir, the only person outside the Railway Conversion League who appears to have understood and acted upon the need for careful consideration of alternative schemes to improve the nation's transport facilities. I trust that others will soon follow your splendid example ; in the meantime, I hope you will allow the correspondence in your columns to continue.

H. BARRS

Worcester,
May 25, 1958.

SIR,—Plainly Mr. J. R. M. Thomas and Mr. A. C. McManus, whose letters you published on May 23, wrote under the disadvantage of not knowing precisely what this correspondence is about. May I therefore be permitted to reinforce your leading article of April 25 by emphasising once more that this discussion is on—or, at any rate, started on—the conversion of Britain's railways, not into highways, but into a motor roadway system reserved for fast traffic. Mr. Thomas should appreciate—in the full meaning of the word—that on the converted railway system there would certainly not be the degree of freedom enjoyed on the highways : the type of regulation he has in mind would be essential, otherwise the converted railways would rapidly degenerate into another highway system, as foretold by Mr. McManus. Accordingly, most of the problems raised by Mr. Thomas are the very problems that railway conversion, and railway conversion alone, will solve. I say " alone " because how else in Britain could Mr. McManus's " properly organised road system—which is built for high-speed, non-stop traffic "—be provided ? Between them Mr. Thomas and Mr. McManus have, I suggest, catalogued most valuably many of the transport evils that beset Britain, the cure for which lies only in railway conversion.

T. I. LLOYD

Newgate Street,
London,
May 27, 1958.

SIR,—One cannot fail to be impressed, if not convinced, by the figures given by Brigadier T. I. Lloyd in your issue for May 23, when he details the possibilities of high-speed road-bus services over former Great Eastern Railway tracks from Liverpool Street to Romford.

I should not like to venture an opinion as to whether the 60 m.p.h. running he forecasts would be safe and practicable, but as a season ticket holder on that line I would like to know what happens in thick fog. Last February we had a taste of it when electric suburban trains, safely spaced by automatic colour-light signals, lost little time on the journey from London to Romford. But when we came to the bus ride from Romford station onwards (and most Romford regulars face a 2 to 4 miles bus ride after leaving their trains) it was chaotic. My own bus journey of 4 miles took an hour. When fog is very thick are we to spend three hours travelling from Liverpool Street to Romford on the " high-speed " buses ? Most of us would choose train travel in those circumstances. Even if fog or heavy snowfalls do not often occur in this country, they happen often enough to make regular suburban travellers prefer trains. This can also apply to long-distance journeys. Before the war of 1939–45 the late Sir Nigel Gresley related that on a then recent day of fog so thick that he had been unable to drive his car, the " Silver Jubilee " high-speed express train ran safely into Newcastle less than five minutes late, thanks to the efficiency of modern railway signalling. How would the road buses have fared in those conditions ?

FRANK A. S. BROWN

Romford, Essex,
May 29, 1958.

Book Reviews

Standard Batch Control. By John L. BURBIDGE. Macdonald and Evans, Ltd., 8, John Street, Bedford Row, London, W.C.1. Price 35s.

THIS book argues for the institution of standard batch control in those areas of the engineering assembly industry where most of the parts used are made in batches. The method is such that when the size of a batch of assemblies has been determined, the size of batches of parts and materials which make up that assembly are also determined, and one result is a simplification of organisation, and a reduction in the flow of paper. Among other results claimed are an increase in the ratio of profit to capital used, a reduction of in-process stocks, and simpler and more effective costing. The case for standard batch control is detailed, well marshalled and clearly expounded. Mr. Burbidge has confined himself to the engineering assembly industry, but, for another reason, the book will be of interest to a wider circle of readers.

In order to build up the case for standard batch control, it has been necessary to attack the concept of the economic batch quantity, which leads to the well-known square-root formula. Now such attacks have been mounted before, and with good cause, for there are many industrial situations to which the formula cannot apply. The principle can also be attacked on general grounds. For example, minimising costs over separate operations may not necessarily minimise the costs of the whole undertaking. One feels that a valid case could have been made (it usually can) against a too rigid application of the formula, on the grounds that the cost curve is generally fairly flat near its lowest point, so that the batch size can be chosen from a generous range, and standard batch control could have been fitted into this framework. But the author has elected to attack the theory of the economic batch size, root and branch, with sometimes regrettable results. At one point he states " If the theory of the economic batch quantity has such serious and obvious deficiencies in practice, is it possible that there is something wrong with the theory ?" There is nothing wrong with the theory unless the first derivative of a function does not give a stationary point when equated to zero, but the author in his subsequent argument does make out a case against wrong application of the theory. For example, not all preparation and carrying charges should necessarily enter the reckoning. If complacency is thereby shattered, he has performed a valuable service.

Two main lines of the attack are concerned with carrying costs. The interest which would have accrued had the capital not been tied up in stocks should, says the author, be calculated at compound rather than simple interest, and should be levied on the value of the article made, which is not the direct cost of making alone, but should include the preparation and carrying charges. However, if these amendments are taken into the reckoning, it can be shown that the batch quantity is altered only from :

$$\sqrt{\frac{2DP}{IC}} \quad \text{to} \quad \sqrt{\frac{P^2}{C^2}+\frac{2DP}{(e^I-1)C}}-\frac{P}{C}$$

where in the author's notation (slightly amended)

P = Preparation cost per batch
C = Cost per piece
I = Interest chargeable per year
D = Rate of consumption per year

and this will give a somewhat smaller economic batch quantity. One suspects that somewhere along the line this more cumbersome formula has been reduced at the not very large cost of some accuracy, for the sake of simplicity.

The author attempts to show that if a smaller batch is made, although the profit margin per piece may apparently be reduced, the percentage profit on the capital actually employed is higher. This argument fails, however, for it has been initially assumed that all capital is always being usefully employed, and the loss of interest on the amount of capital tied up in stocks is already accounted for in the calculation.

Again, in Chapter 3, one fallacy occurs close upon another and it is here necessary to quote :

" If we consider a firm which fixes all its batch quantities by the Economic Batch Quantity formula and realise that this firm could probably halve all its batch quantities without increasing costs more than 0·5 per cent, it will be obvious that the converse is also true, and that the firm has capital invested in stocks and work in progress to the value of half the ' stock and work in progress ' figure in the accounts at the remarkably low rate of interest of 0·5 per cent.

" This sum could probably be invested in new plant and equipment, which would pay for itself in three or four years. In other words, it could be reinvested at 25 to 33⅓ per cent."

In the former case, the " remarkably low rate of interest " is not 0·5 per cent but more than 10 per cent (10 per cent being the working figure throughout the book for interest on capital). In the latter case, if the freed capital can earn 25 to 33⅓ per cent, why are we working with an interest rate of 10 per cent for invested capital in the E.B.Q. formula ?

These, and other blemishes, are probably the fruits of over-enthusiasm, which is a pity, for the author's approach is refreshing and imaginative, and there is much sense in his contention that standard batch control would

assist in the study of the whole concern. He mentions linear programming for this purpose, but operational research workers will be surprised to see it described as one of their simpler techniques, just as they will wince at the Americanism "operations research."

Most of the book is naturally devoted to standard batch control, and Mr. Burbidge has not been content merely to explain the theory, but describes the practical operation of his scheme, and its effect upon specialist departments, in great detail. These chapters are full of useful ideas, and are well worthy of study.

Mechanical Vibrations. By A. H. CHURCH. Chapman and Hall, Ltd., 37, Essex Street, London, W.C.2. Price 54s.

THIS work is a rewritten and enlarged version of the author's previous book *Elementary Mechanical Vibrations*, published by the Pitman Publishing Corporation, although it is presented as a first edition. It is a typical textbook, having been based on the author's courses of lectures at New York University. The usual topics of undamped and damped one deg. of freedom problems are dealt with in great detail. The main parts of the theory are carefully derived, little being left to the imagination of the reader. Considerable use is made of vector diagrams to explain the physical meaning of the algebraic terms involved. The concept of equivalent systems is emphasised throughout the book; examples are given on the calculations of equivalent mass or inertia and of equivalent stiffness. A short chapter on electrical analogies is also included. Multi-mass torsional problems, including the Holzer method for analysis, critical speed calculation and the dynamics of single-cylinder engines is discussed in some detail. To find a chapter on balancing of rotating masses and reciprocating engines in a book of this nature is perhaps surprising, but useful, although most students will have had access to this material already in the many books on mechanism.

The book is satisfactory as an elementary textbook and is a considerable improvement upon the author's earlier effort. The many problems at the end of each chapter and the occasional, worked-out example in the text will be very helpful to the serious student. The book is disappointing, however, when more than the standard undergraduate material is sought for. Section headings such as "Vibration Instruments" or "The Gyroscopic Effect of Impellers upon the Critical Speeds of Shafts," look exciting to those seeking a little more specialised information, but are dismissed in only a page or two without any significant attempt at analysis, nor are references given, other than to a few well-known textbooks, some of which are not particularly up to date. The book is well produced with many clear illustrations and the index would appear to be adequate. It is therefore a great pity that the price, 54s., will deter the average undergraduate from acquiring a copy, at any rate in this country.

Advanced Mathematics for Technical Students, Part II. Second edition. By H. V. LOWRY and H. A. HAYDEN. Longmans, Green and Co., Ltd., 6 and 7, Clifford Street, London, W.1. Price 21s.

IT is often claimed by engineers that the mathematics taught to technical students in universities and technical colleges has too much of the academic flavour and that too little attention is paid to the solution of practical engineering problems. The series of mathematical textbooks by Geary, Lowry and Hayden, although undoubtedly leaning towards the academic, do appear to go a long way towards striking a reasonable compromise in this respect. In Parts I and II in *Advanced Mathematics for Technical Students*, the authors aim to cover as broadly as possible all the mathematical course work likely to be required by students taking the Higher National Certificate or degrees in science and engineering.

Part II, the volume under review, is intended more specifically for those students taking the final year of the Higher National Certificate or Part II of an engineering degree. Science degree students taking mathematics as an ancillary subject would require certain sections from Part II and almost all of Part I. With such varied interests in mind, the authors give helpful guidance as to the selection of material for particular courses of study. Looking at this textbook from the point of view of an engineer, several leading questions might well be asked. Does it provide a sound basis for teaching and learning engineering mathematics? Can it be used as a book of reference by the student? To these two questions the answer is certainly in the affirmative. Each subject is concisely and logically explained and, in some 400 closely printed pages, an extremely wide range of material is set out clearly in sections with a notation that is in line with current engineering practice. Are the examples merely exercises in abstract mathematics or do they contain a reasonable proportion of problems dealing with practical engineering? To this question, the answer is more doubtful. In a book of this scope it would seem unfortunate that so very few of these problems should be of a numerical nature. Finally, how is the subject matter balanced between the respective requirements of mechanical, civil, electrical and other branches of engineering? Here, except for the omission of any section on hydrodynamic lubrication only electrical engineers will have grounds for complaint. In view of the growing importance of electrical engineering and, in particular, electronics, more space could have been assigned to material from these subjects to meet the needs of present-day students.

Reactor Heat Transfer. By W. B. HALL, B.Sc. (Eng.), A.M.I.Mech.E. *Nuclear Engineering*, Monograph No. III. Temple Press, Ltd., Bowling Green Lane, London, E.C.1. Price 10s. 6d.

WRITTEN by the Research Manager of Windscale, this book is an attempt to compress something of the subject into about seventy pages, and succeeds very well in spite of the confined space. The first chapter is general in scope, and in it the author endeavours to introduce the fundamental principles of heat transfer by convection. The well-known dimensionless groups are interpreted in physical terms and the reader is referred to other sources for the methods of analysis by which they are derived.

Once he gets down as closely to details as his framework permits, the author naturally dwells on the kind of reactor favoured by the immediate British nuclear power programme. He describes the system briefly, and deals with the temperature distribution in the fuel channel, employing a form of Ginn's equation for the maximum surface temperature of the element. The need for throttling is explained before going on to discuss the pressure drop through the core. An equation for the pressure drop is evolved on the assumption of incompressible flow, Guggenheim's equation then being quoted as a more accurate solution. Pumping power and the comparison of coolants in relation to it are treated briefly. A third and final chapter skims over what are called miscellaneous topics, such as liquid metallic coolants and their comparison with gaseous coolants, heat transfer in the can, and temperature gradient along fins.

Like its two predecessors in this series of monographs, the book is bound in thick paper covers, has a useful key to the notation at the front, and is provided with a rather meagre index at the back.

Structural Design in Metals. By C. D. WILLIAMS and E. C. HARRIS. The Ronald Press Company, 15, East Twenty-Sixth Street, New York, 10, N.Y. Price 8 dollars.

THIS is the second edition of an American textbook giving an introduction to structural design in steel. Consideration is given, however, to the use of other metals, such as light alloys, and to structural design in aeronautical engineering. Extensive revisions are included in the second edition, with up-to-date U.S. specifications and codes of practice noted, and with a chapter on rigid frame design and another on design with light-gauge steel. Plastic methods of design are not mentioned.

Biege-und Torsions Verformungen Dünnwandiger Stäbe mit Offenem Profil. By J. I. JAGN. B. G. Teubner Verlagsgesellschaft in Verwaltung, Goldschmidtstrasse 28 (Postschliessfach), Leipzig, C.1. Price: DM.7.20.

THIS treatise, which first appeared in Russia in 1952, deals with problems of combined torsion and bending (which were first treated by S. P. Timoshenko in 1905–6) in a form which it is hoped will make a somewhat complicated subject accessible to the student. The book falls into three parts: general theory of combined bending and torsion; applications to thin-walled members with open profile, and practical examples.

Books Received

Better Report Writing. By W. H. Waldo. Chapman and Hall, Ltd., 37, Essex Street, Strand, London, W.C.2. Price 38s.

Telecommunications Economics. By T. J. Morgan. Macdonald and Co. (Publishers), Ltd., 16, Maddox Street, London, W.1. Price 50s.

Basic Electrical Engineering. By Robert H. Nau. The Ronald Press Company, 15, East 26th Street, New York, 10, U.S.A. Price 7 dollars.

Motion Time and Study. Fourth edition. By R. M. Barnes. Chapman and Hall, Ltd., 37, Essex Street, Strand, London, W.C.2. Price 74s.

Chemical Reaction Engineering. Vol. I. Edited by Dr. K. Rietema. Pergamon Press, Ltd., 4 and 5, Fitzroy Square, London, W.1. Price 80s.

The Directory of Shipowners, Shipbuilders and Marine Engineers, 1958. Tothill Press, Ltd., 33, Tothill Street, Westminster, London, S.W.1. Price 40s.

The Coal Industry of the U.S.S.R.: Part 2, Appendix 4, Roof Supports. National Coal Board, Hobart House, Grosvenor Place, London, S.W.1. Price 5s. 6d. (post free).

Hydraulics and Fluid Mechanics. Tenth edition. By E. H. Lewitt. Sir Isaac Pitman and Sons, Ltd., Pitman House, Parker Street, Kingsway, London, W.C.2. Price 37s. 6d.

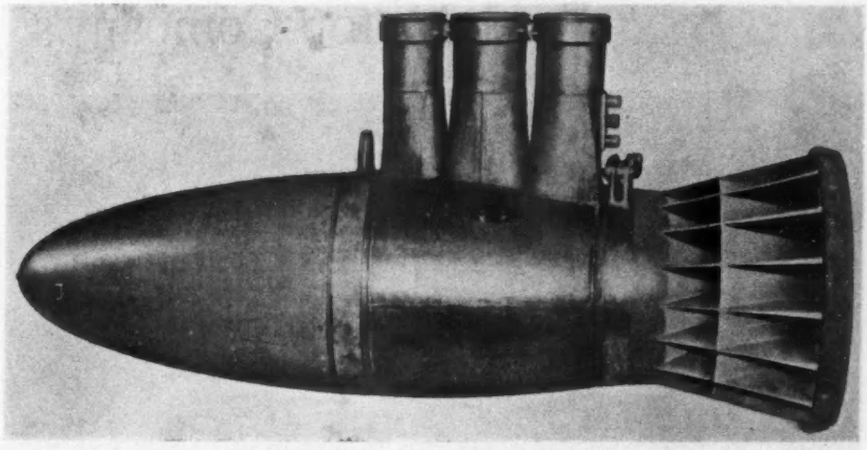
Engineering Materials Handbook. Edited by C. L. Mantell. McGraw-Hill Publishing Company, Ltd., McGraw-Hill House, 95, Farringdon Street, London, E.C.4. Price 167s.

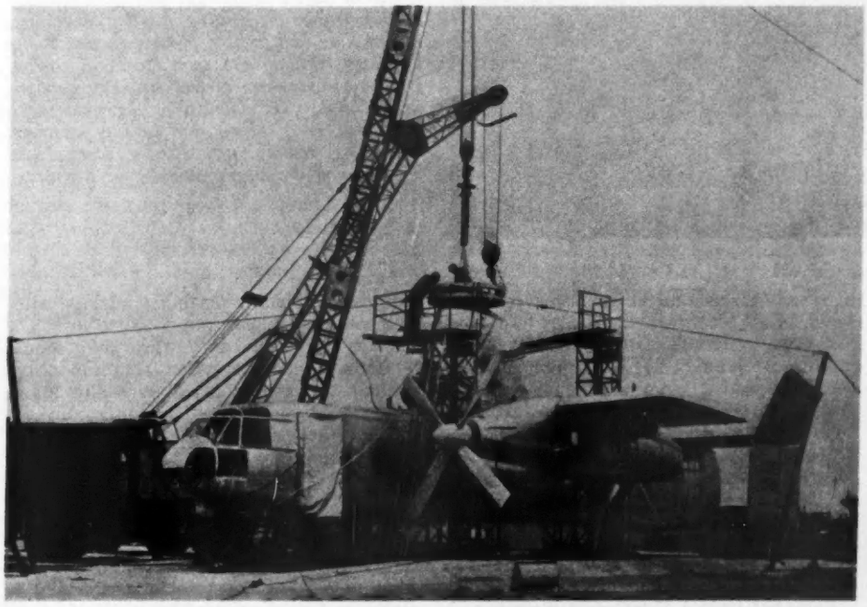
Grading of Metallic Resistors for Electric Motors—with Examples. By E. W. Brass. The Association of Engineering and Shipbuilding Draughtsmen, Onslow Hall, Little Green, Richmond, Surrey. Price 3s.

Daylight Through the Mountain. Edited by Frank N. Walker. Published by Sir Isaac Pitman and Sons, Ltd. (London), and distributed by Sir Isaac Pitman and Sons, Ltd., 381/3, Church Street, Toronto, Canada, for the Engineering Society of Canada. Price 45s.

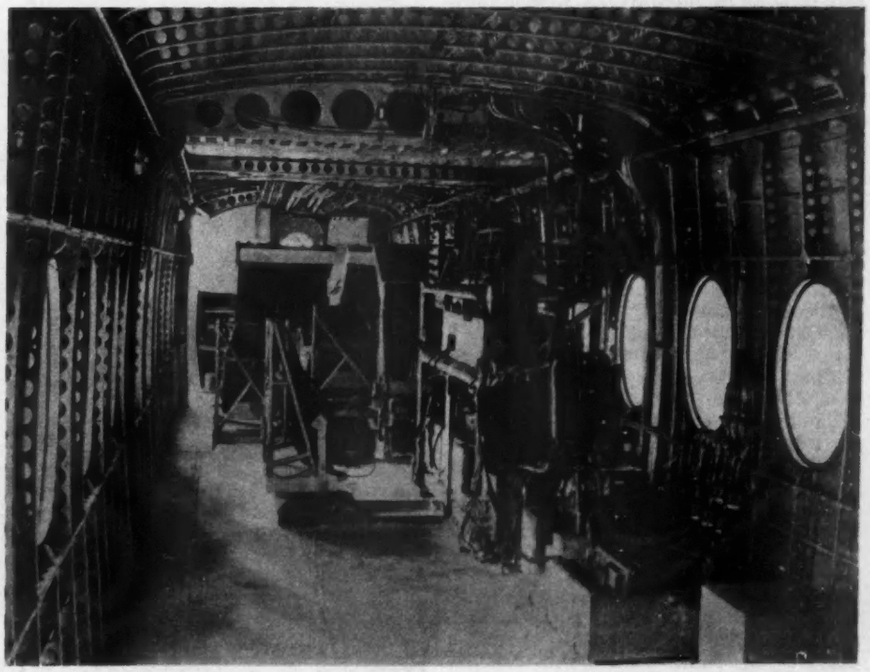
"Rotodyne" Transition to Autogyro Flight

The Fairey "Rotodyne" has now completed fifteen transitions from helicopter to autogyro flight, while flying straight and level and without loss of height. Over ninety flights have been made by the "Rotodyne" since it first flew last November. This test programme is claimed to rival that of the new Lockheed "Electra," which, with fifty flights within three and a quarter months of its maiden flight, established a record. The Fairey Company states that hovering and vertical climb performance of the aircraft have already exceeded predictions. It has lifted slightly more than its designed all-up weight of 33,000 lb, achieved a vertical rate of climb 1300ft per minute and a forward climb of 2400ft per minute. In the autogyro condition speeds exceeding 150 m.p.h. have already been achieved. Design cruising speed of the "Rotodyne" is 185 m.p.h. The tip jet unit SHOWN ABOVE has an experimental noise suppression nozzle which is expected to reduce the present high noise levels to entirely acceptable values for commercial operation in built-up areas. Development of the tip jets and silencer has been proceeding on a single blade rotating rig at White Waltham and a 25-hour endurance test on the main simulator rig at Boscombe Down has been concluded. The instrumentation installed in the prototype, ILLUSTRATED BELOW, includes three auto-observer panels. Several hundred strain gauges are fitted to the rotor and airframe. Readings from the rotor gauges are transferred to the fuselage recorders through sliprings. The technique has given outstanding results according to Fairey.

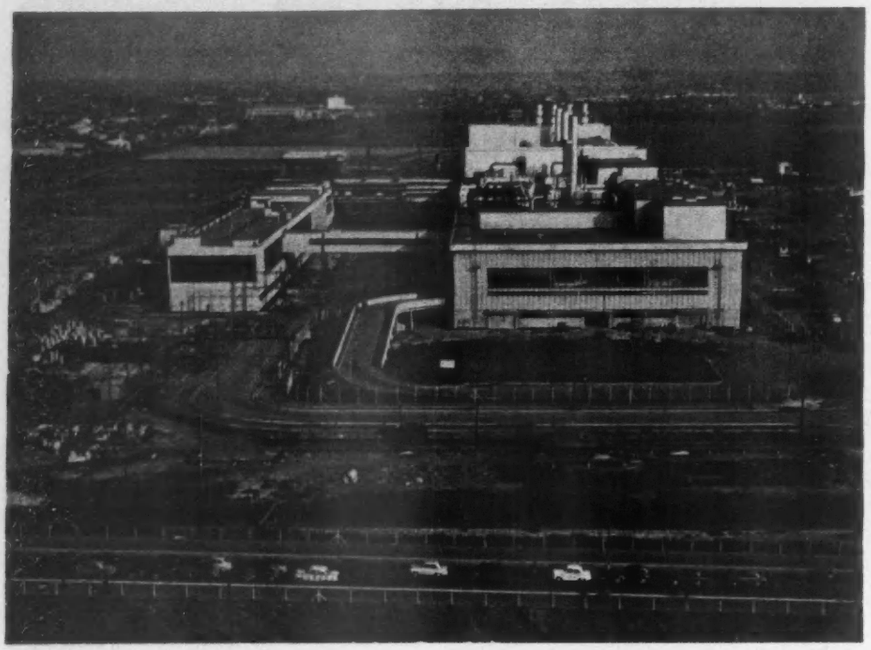




With each new increment of flying speed during the tests, measurements were made of fluctuating stresses, blade flapping angles, clearance from droop stops, and airframe vibration levels. The actual prototype was subjected to measurement tests (ILLUSTRATED ABOVE) of distribution of stiffness and damping factors. The rotor head and blades were removed and replaced by an equivalent mass. A rotating out-of-balance force was then fed in at the head and airframe responses measured over a frequency range of 0·5 to 3 c/s. The effect of lift was simulated by slinging the aircraft to a jib and applying variable lift, up to the aircraft weight, while the tests were in progress. The lift force was cushioned through air jacks because of the very low frequencies involved. The information obtained was fed back into model tests and gave a complete picture of ground resonance characteristics. As a result of these tests the undercarriage suspension characteristics had to be altered to counteract an unusual combination of vibration modes which could have led to ground resonance. Preflight testing of the "Rotodyne" is, perhaps, the most exhaustive ever given a British aircraft. Development of a "Rotodyne" with an all-up weight of about 70,000 lb, a rotor diameter of 120ft, and capable of carrying 200 passengers would appear to be feasible



Ford Motor Company's Thames Foundry at Dagenham



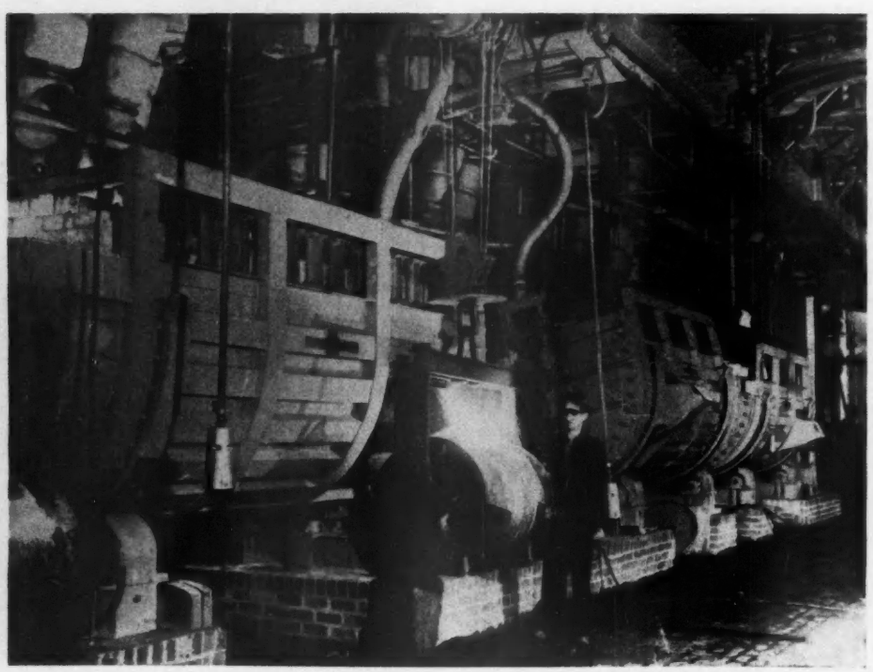
The modernisation and expansion programme announced by the Ford Motor Company, Ltd., in 1954 is now approaching completion. An important item in that programme is the new Thames foundry which the company has built at Dagenham, at a cost of nearly £8,000,000, and which has recently begun operation. This foundry was planned by the company's engineers following a detailed study of modern Continental and American foundry practice; its layout and equipment are such that excellent working conditions are provided. This illustration (left) shows the extent of the two buildings. The main building accommodates the melting, pouring, moulding, coremaking and fettling operations and in the ancillary building the sand handling, casting cooling, sand removal and grinding sections are housed. The foundry is designed for a daily output of about 400 tons of castings, consisting mainly of cylinder blocks and heads and the larger castings for tractors.

IN our issue of November 29, 1957, we illustrated and referred briefly to the Thames foundry at Dagenham, Essex, which has been built by the Ford Motor Company, Ltd. The new foundry, which is additional to the company's existing foundries at Dagenham and Leamington, is situated on a site of 22 acres and has a floor area of 533,200 square feet. In its design, the company's engineering staff have kept in mind the need to provide an up-to-date "work flow" foundry incorporating the maximum degree of mechanisation and automation, thereby reducing the human effort to a minimum. The foundry was completed in rather less than three years, a start having been made on the pile driving in March, 1955.

As mentioned above, the Thames foundry comprises two buildings. The main building, measuring 1200ft by 180ft by 70ft, accommodates the principal foundry operations. This building is a two-floor structure, the lower floor being occupied by the maintenance department, offices, stores and all the employee amenities. The upper, or main operating, floor of this building is arranged in bays measuring 60ft by 60ft, and steel columns at 60ft centres support lattice girders which form the fabric of the building. These girders are utilised for carrying a great deal of the mono-rail conveyor equipment and the material storage hoppers, so that individual supporting columns are eliminated and the maximum free working space at floor level is provided.

Throughout the foundry the fullest possible use is made of mechanical handling equipment. Pig iron and coke are brought to the foundry by rail wagons and particular consideration has been given to coke handling to keep breakages to a minimum. There are two 5-ton telpher cars for conveying coke and limestone to storage hoppers adjacent to the cupola melting units. The charges of pig iron, scrap coke and limestone are weighed and loaded by skip hoists into four 108in diameter hot-blast, water-cooled cupolas. Each pair of cupolas is served by a "Cupodel" hot-blast plant, and for each cupola there is an 8-ton hot metal receiver. From the receivers the metal is transferred, as shown in an accompanying illustration, to a 2000 lb capacity ladle from which the heavy castings are poured. There are ten of these ladles suspended from electrically-operated towing and hoisting units; there are also four ladles of 1000 lb capacity. Another item of equipment in the melting section is a pig-cast machine, the capacity of which is 20 tons an hour, for "pigging" surplus metal.

The two moulding lines are fed from their own automatic sand systems and are well equipped with smoke and fume collection apparatus. In each line there are eight semi-automatic moulding machines working within a continuous 800ft mould conveyor. The castings are removed from the drag mould by hook carriers suspended from a monorail cooling conveyor located vertically above each mould conveyor. This latter conveyor transfers them to the ancillary building where, after cooling for about three hours, they have the sand and cores removed by vibrators before passing through a battery of grinding machines for the removal of any metallic surface irregularities. The castings are then returned by monorail conveyor to the main foundry building for cleaning, and, finally, to eight fettling lines for finishing and, if



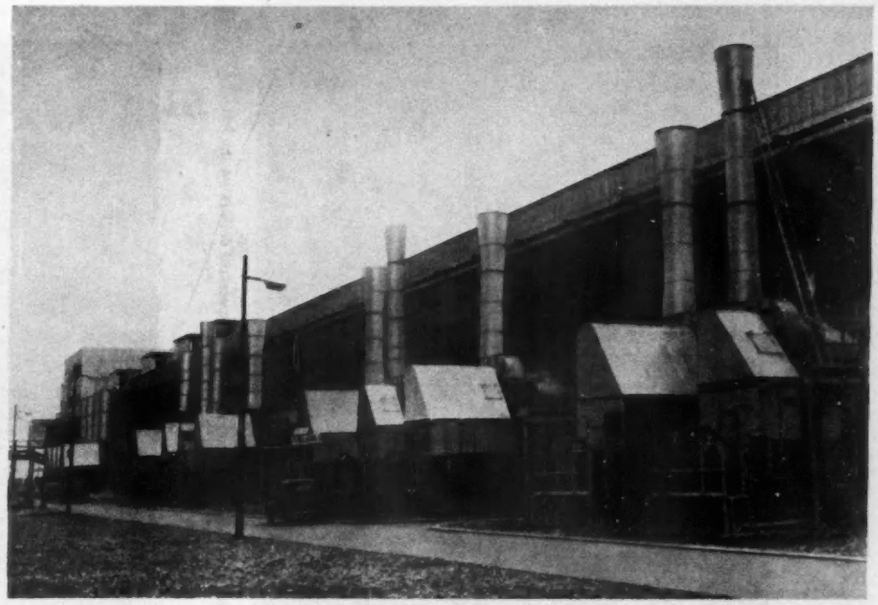
Metal being transferred from one of the hot metal receivers into a 2000 lb capacity ladle from which castings are poured

required, for water test. The hook carriers suspended from the conveyor system are illustrated below.

The cores are formed and baked at least twenty-four hours ahead of the moulding process. The core shop, which is centrally situated in the main building, is so arranged that cores can be supplied as required to each of the moulding lines. There is a central high-level station for mixing the core sand. The operation is fully automatic and is performed by a " Sinex " proportioning system. There are four groups of batch weighers which handle the proportioning of the dry sands and the additives, and three metering pumps for each group deal with the liquids. Formula selection is made by means of an Oerlikon punched card system. Ten basic mixes are interpreted by punched cards, the variations of each basic mix being obtained as necessary by altering the pattern of the card punching. All the cores are made by thirty-nine semi-automatic vertical core-blowers which force the sand mix into boxes producing the different kinds of cores required. Part of the core-making line is shown in one of the illustrations. The cores are conveyed to five continuous horizontal ovens which are built at an elevated level, thus assisting easy operation as well as providing storage space beneath. After delivery from the ovens the cores have their external faces coated with a special wash to protect them from the molten metal ; this wash is dried in three horizontal ovens. There are nine core-grinding machines for removing surplus sand where required.

The excellent working conditions provided in the new foundry have already been mentioned. The air purifying system, for example, changes the whole air content of the building seven times an hour, and in the moulding and fettling sections as many as sixteen times an hour. All the air entering the building is cleaned, warmed in the winter and fan-cooled in the summer. There are steam heaters around the perimeter of the building and over the main aisles and doorways to compensate for heat losses, and the windows and fans are thermostatically controlled to allow for variations in temperature.

The exhaust system incorporates twenty-six " Roto-Clone " hydrostatic precipitators, which together deal with 42,000,000 cubic feet of air per hour. As well as controlling the dust and fumes at source, the precipitators

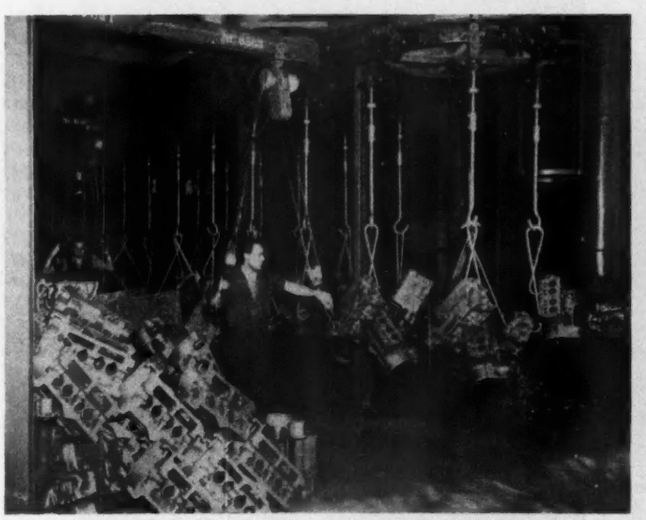


There are twenty-six hydrostatic precipitators employed in the exhaust system. They handle 42,000,000 cubic feet of air an hour

scrub out the foreign matter before discharging the clean air to atmosphere. It has been stated that about 35 tons of sludge are taken daily from the precipitators, the sludge, of course, being made up of dust and fume particles. Twelve of the precipitators are mounted on the roof of the main foundry building, their function being to control the dust from the moulding and shake-out area, core grinders and spot-blast cabinets. They are fed by a total of 800 gallons of water a minute and discharge continuously the collected material in the form of a slurry to a gravity sluicing system, the slurry serving to augment the water supply to the sluiceway. Slurry and water are led to two large settling pits from which the water overflows to cooling ponds before being recirculated to the sluice-way. The remaining fourteen " Roto-Clone " precipitators are arranged, as shown by the illustration above, at ground level outside the ancillary building. Their purpose is to control the dust at the primary knock-out section, the vibrators, grinders and back-scrap separation plant. These fourteen precipitators have built-in conveyors which continuously eject the collected material as sludge to skips for transfer to settling pits. After their initial filling the skips require only sufficient water to make up for that lost by evaporation and the moisture contained in the ejected sludge. The operation of the precipitators is fully automatic ; they are electrically controlled from central points within the buildings.

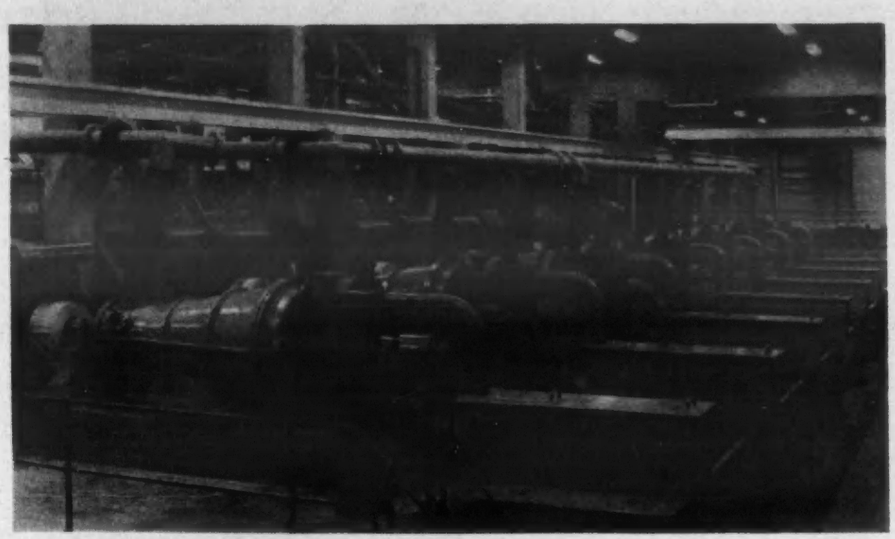
The installation of the services essential to the foundry involved a considerable amount of work. The steam and gas mains and the power cables all follow the line of a common trestle-way to the new site from the Ford Motor Company's power-house and coke ovens which are approximately half a mile away. The electric power required to drive all the equipment in the foundry is distributed by five substations situated on the roof of the main building.

The Thames foundry is manned by 1800 operatives, most of whom have been transferred from the company's older foundry at Dagenham.

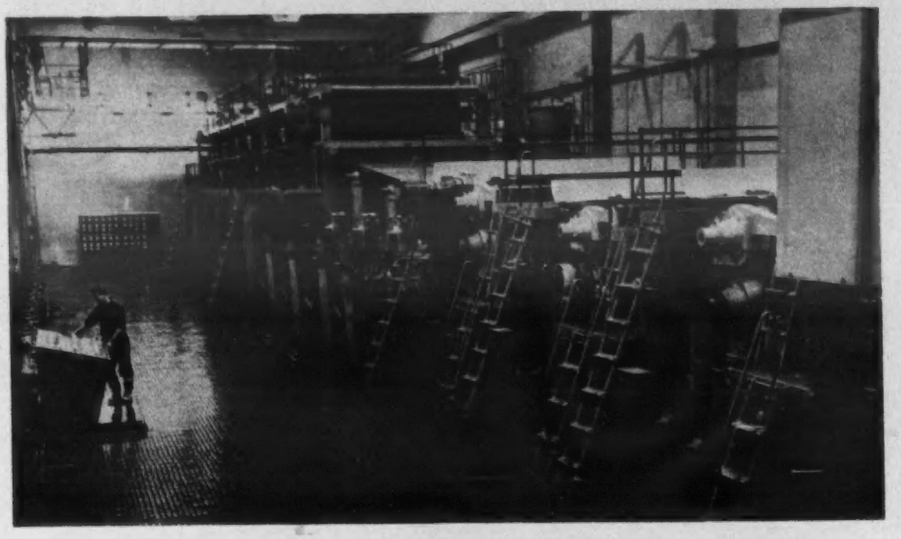


(Left) Monorail conveyor systems are installed throughout the foundry. Here castings are being transferred, after cooling, to the fettling lines conveyor. (Right) This core-making line is equipped with six core-blowing and core-stripping machines on which various cores for tractor castings are made

PAPER BOARD MILL AT THATCHAM, BERKSHIRE



Bank of refineries for final treatment of stock



Wet end of machine, including the main press section. The drive control desk is on the left

Part of the stacked dryers with the calenders and rewinder in the background

Machine drive annexe with drive units, motor generators and switchboard

Board Mill at Thatcham

On a 40-acre site at Thatcham, near Newbury, in Berkshire, a paper board mill has been completed recently for Colthrop Board and Paper Mills, Ltd., a member of the Reed Paper Group. The new mill is a completely integrated unit having its own power station, workshop, water treatment plant, in addition to the machine and its ancillaries. Four kinds of board are manufactured and the machine produces folding box board 110in wide at 600ft per minute. Our illustration gives an overall view of the mill buildings with the raw materials store at the top, then the machine on the right with the preparation plant, and the single-storey workshop building on the left, and finally the salle. Part of the power house can be seen at the bottom.

DURING the early months of this year, a new board mill was put into commission by Colthrop Board and Paper Mills, Ltd. It occupies a 40-acre site near Thatcham, Berkshire, where paper making is known to have been in existence for over 200 years. The new North Board Mill is a completely integrated unit having, in addition to the main production installations, a raw materials building, a finishing department, a water treatment plant, maintenance workshops and its own power station. The board machine, which is 325ft long and makes mainly folding box board, 110in wide, will double the output at Thatcham. An area of 183,610 square feet is covered by the main buildings, which have a length of over 1000ft.

Mill Buildings

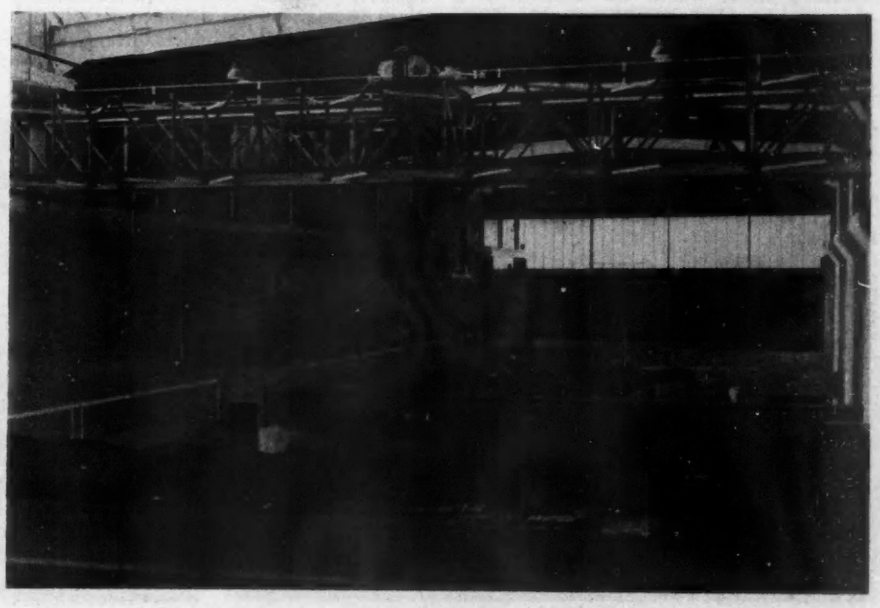
The site, which is low-lying and tended to be waterlogged at times, presented difficulties in construction, especially where heavy loads had to be taken and any possibility of settlement avoided. Bored, piled foundations, cast *in situ*, were adopted, involving some 2400 piles. Reinforced concrete construction was used, in general, for the buildings. Where acid conditions were likely to obtain sulphate-resisting cement was used and all the buildings are separated by expansion joints. The raw materials building, 305ft long by 192ft wide by 58ft high, is divided into three bays (one of which can be seen in our illustration), each enclosed by reinforced concrete walls which act both as retaining walls and fire breaks and are surmounted by a steel portal framed roof. Cross-reinforced concrete walls subdivide each bay into cells. Across the end of the bays is the "hydrapulper" area, and this abuts on to the three-storey preparation plant building from which it is separated by a fireproof wall.

The latter building is 180ft long by 110ft wide by a height of 64ft, and has a roof of reinforced concrete slab with asphalt roofing laid on cork insulation. It houses chests, refiners, screens and thickeners, and a china clay and alum store. There are three sections in the machine house, namely, the screens area, the machine house itself, and the drive annexe. The machine house has two expansion joints in its length of 435ft and has a width of 75ft, including the annexe, which has intermediate floors, the upper storey accommodating the ventilation plant for the board machine, and the first floor the drive equipment. The flat slab ceiling is carried by cambered reinforced concrete beams, except in the way of the stack dryer, where there is a ceiling of heated enamelled steel plates. Granolithic flooring is general, but at the wet end of the machine there are red brick paviours laid on acid-resisting asphalt.

Adjoining the preparation plant building and the machine house there are the workshops for which a single-storey steel-framed building, measuring 395ft by 192ft, is provided. Steel-frame construction was also adopted for the salle, which is adjacent to the dry end of the machine house, from which it is separated by a fireproof wall. The overall dimensions are 270ft by 162ft, and there are three crane bays, one for trimming and two for storage, and a fourth bay without a crane. Land and storm water drainage set certain problems, and it was found necessary to supplement an improved watercourse by an 87,000-gallon tank to collect storm water.

Mill Machinery

Raw materials are delivered to the raw materials building at the western end of the plant, the three bays being supplied with



One of the three bays in the raw materials building

mixed waste, selected waste and virgin pulp respectively. At each bay is a 2-ton overhead electric travelling crane which is used for unloading purposes and for supplying the four Black-Clawson "hydrapulpers." These prepare stock for four separate systems, a 20ft diameter continuous extraction unit of 8 tons per hour capacity, supplied with mixed waste by a heavy-duty slat conveyor, serves the "middles" system, while a similar unit of 16ft diameter is used for "underliner" stock. Both have steam injection to speed up disintegration and also junk removers and raggers. "Liner" and "backs" stocks are prepared in two 14ft diameter batch hydrapulpers, the former stock being pumped to a duo-cycling system, and the latter is pumped either to a cleaning system or to the unrefined stock chest. There is a control station for each "hydrapulper."

In the preparation building the main plant is on the first floor with the stock chests below, while on the second floor are located tanks for fresh water, backwater, dilute alum solution, size solution, clay mixture and vitriol. Stock for the "middles" system is cleaned by a battery of Vickery Dirtecs, which remove the solids and pass the stock on to four Black-Clawson "classifiners," which reject the lighter impurities. The consistency of the accepted stock is then raised from about 0·8 to 3·5 per cent in five thickeners or deckers, supplied by the Watford Engineering Company, Ltd., and the surplus white water is returned for use in the 20ft "hydrapulper" via a regulating box. Reject material from classifiners passes through a disintegrator pump and on to a selectrap from which accepted stock is returned to the system. The "underliner" stock can be treated as for the "middles" or passed direct to the unrefined stock chest.

"Backs" stock can be treated in a "hydrafiner," through which it can be circulated for a predetermined number of passes, or passed to the refiners. Treatment of the "liner" stock is by a Black-Clawson "hydrafiner" duo-cycling system consisting of three "hydrafiners," a duo-cycling chest and a blending chest, both of which are vertical tile-lined units, the former being divided by a vertical midfeather. The pipework is of stainless steel and a preset counter automatically controls the number of passes the stock makes through the "hydrafiners" before passing to the blending chest, where the consistency is reduced from 5½ to 3 or 3½ per cent. There are eleven tile-lined, reinforced concrete stock chests, all fitted with agitators. All four stocks receive final treatment in a battery of seven Walmsley conical refiners, illustrated herewith, which discharge into troughs feeding the various machine chests. Foxboro-Yoxall instruments record chest depth levels and consistency and there is a control desk for the pumps and agitator motors. Consistency control is applied to all four systems before and after refining, to give close regulation over a wide range.

Three asphalt-lined concrete tanks are available for dissolving aluminium sulphate blocks, while an automatic plant emulsifies concentrated fortified rosin size with water to give a 5 per cent solution. Means are provided at various points for the addition, by metering, of alum and size solutions to the stock.

The board machine, which is designed for a trimmed width of 110in and a maximum speed of 600ft per minute, incorporates in its design many details developed by the company's engineering department and was built by Walmsleys (Bury), Ltd., and Walker Brothers (Wigan), Ltd. All four stocks are delivered to separate compartments in a stainless steel headbox sited above eight dual-drive bird screens, through which they pass at a controlled rate. From the bird screens the diluted stock is discharged through stainless steel outlet boxes to conical mixing boxes for deaeration and mixing with white water. After this operation, the stock flows to the vat section of the machine which consists of eight 48in diameter cylinder moulds and vats, six being of contra-flow pattern and two designed for contra-flow or uniflow operation. Stainless steel flow spreaders are connected to the first up-flow passage of each vat, all of which have cast iron box section sides, incorporate a mould air extraction system and are provided with a 20in diameter rubber-covered top couch roll mounted on adjustable arms.

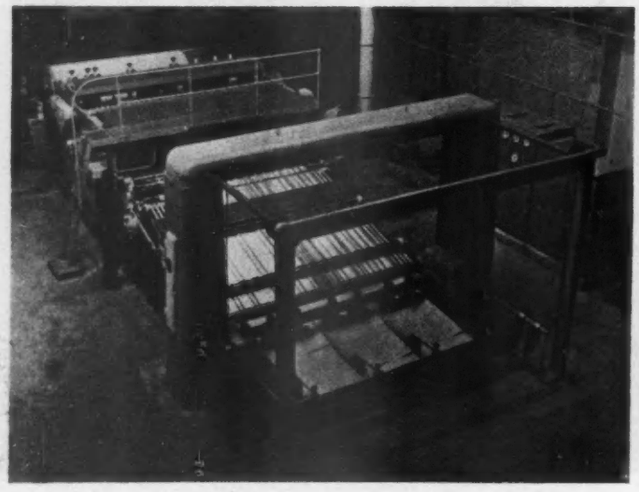
Following the vat section is a 28in diameter extractor roll, then a 30¼in diameter suction return roll leading to five primary presses, of which the fourth is a suction press. In the main press section there are two plain presses with a suction press between them, and all have 26in diameter rolls with granite top rolls. The wet end of the machine including the primary and main press sections, are illustrated on page 854. There are Vickery conditioners for the two felts, the cleaning of which is assisted by suction squeeze rolls and Nash vacuum pumps. Twenty-six 5ft diameter steam-heated cylinders, arranged horizontally in two tiers, together with a Ross-Grewin vapour absorption system, form the pre-dryer section which is covered by a hood from which extraction fans discharge to exhaust towers. In the main dryer, part of which we illustrate, there are 130 3ft 6in diameter steam-heated cylinders arranged in eight vertical stacks. A vapour absorption system using high velocity hot air is installed and also a smoothing press consisting of 24in diameter chilled iron rolls. Above the stacks is a false ceiling of enamelled steel which is heated to prevent condensation, while fans remove the humid air at a high level. The Carrier-Ross Engineering Company, Ltd., supplied the vapour absorption, heating and ventilating systems, the equipment being installed in a self-contained fan annexe above the drive annexe, which acts as a supply duct to the fans. The steam circulating and condensate system for the drying cylinders was supplied by Reiss Engineering Company, Ltd.

Two seven-roll finishing calenders are installed, all are fitted with Vickery doctors, and five rolls in the first stack have water doctors to give a good gloss. The double-arm drum pattern reel-up machine winds reels up to 76in diameter.

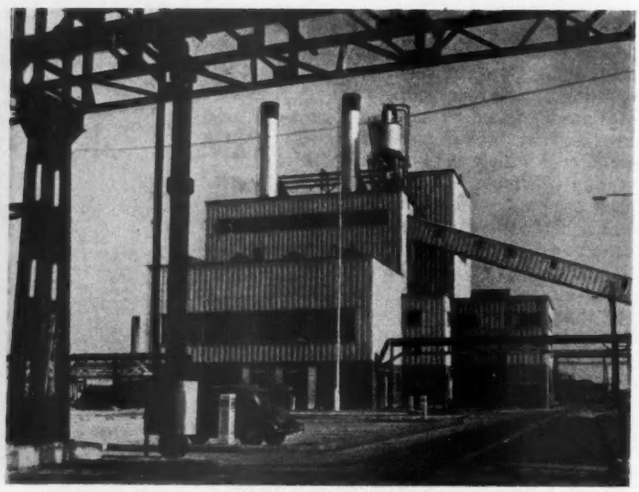
A Harland interlocked sectional electric drive, illustrated on page 854, having an operating speed range of 100ft to 600ft per minute and a crawl speed of 30ft per minute, powers the machine. There are twenty-five driving units, consisting of a motor and gearbox and ranging from 5 h.p. to 80 h.p., and the driving shafts, which are fitted with flexible couplings, are connected to the machine through openings in the annexe wall. A 775 h.p. synchronous induction motor drives the main 500kW generator and a flat-back open circuit breaker switchboard supplies the section drive motors.

Baldwin "Atomat" radiation gauges, installed at two points, continuously check the board substance and recording instruments indicate any change in weight so that immediate adjustments can be made. At the end of the machine is a Masson Scott slitter and rewinder having a Hackbridge and Hewittic "Velotrol" grid-controlled mercury-arc rectifier supplying variable speed d.c. to a Mather and Platt motor, giving a speed range of 200ft to 1600ft per minute. Below this unit is a broke beater, provided by the West End Engine Works (Edinburgh), Ltd.

A motor-driven trolley conveys the reels to a balcony projecting into the salle building, from which they are transferred by crane to a



Duplex super cutter in the salle



Power station housing two stoker-fired boilers and turbo-generator

Masson Scott duplex super cutter, illustrated herewith, or a Simplex cutter or a Thrissell slitter and rewinder.

The power plant building, of which we reproduce an external view and which is separate from the mill, has a ground area of 12,000 square feet and is divided into the boiler-house, turbine house and water treatment plant annexe. The main stanchions and beams are of reinforced concrete and the cladding is partly in brick but mainly in asbestos cement sheeting, and the whole is carried on 265 piles cast *in situ* by the Piling and Construction Company, Ltd.

Steam is raised at 528 lb per square inch and 780 deg. Fah. at the superheater outlet, by two three-drum, vertical tube, stoker fired water-tube boilers, manufactured by International Combustion, Ltd., each having a duty of 88,500 lb per hour. The boilers have Senior economisers and are equipped with separate forced draught, secondary air and induced draught fans and Howden's Multi-Vortex grit arresters. Coke-breeze assisted by oil fuel is burnt, the oil burning equipment being supplied by Associated British Combustion, Ltd. The coke-breeze is delivered by rail, the trucks being handled by a Strachan and Henshaw wagon tippler, and the fuel is transferred by belt conveyors to two suspended bunkers. The daily intake of fuel is 250 tons and provision is made for ground storage of 10,000 tons. A hydraulic system deals with the ash.

The feed water treatment plant, provided by Neckar Water Softener Company, Ltd., has a capacity of 15,000 gallons per hour and treats canal water taken from the outlet culvert of the condenser cooling water supply. From surge tanks the water flows through a Weir deaerator to the main and is heated to 200 deg. Fah. and forwarded to the boiler by a Mather and Platt motor-driven pump. There are also two pumps of similar make but of half the capacity and in addition two Weir turbo feed pumps of the same rating.

Electrical power is generated by a 7500kW Metropolitan-Vickers, direct driven turbo-alternator with a pass out steam quantity of 120,000 lb per hour at 35 lb per square inch. With no pass out steam being taken an output of 3500kW is obtainable from the set operating as a fully condensing machine. The alternator generates at 11kV and can be paralleled with the supply from the Electricity Board. Auxiliary generating plant consists of a 500kW back pressure turbo-alternator. British Thomson-Houston switchgear is fitted. All motors, with a few exceptions, ranging from fractional to 270 h.p. are of Mather and Platt manufacture.

Water supplies are drawn from the Kennet and Avon canal by three Mather and Platt borehole pumps which deliver to a 320,000 gallons capacity storage tank. After being used for condenser cooling the water is used for production purposes and any surplus is returned to the canal via the storm water collecting tank. Surplus backwater from the mill is treated in a clarification plant consisting of a dump tank, splitter box and two 50ft diameter Dorr clariflocculator tanks capable of handling 600,000 gallons per day. Sludge from the tanks is returned to the "middles" hydrapulper and the clarified effluent is given further treatment before being returned to the canal. A Glenfield and Kennedy microstrainer deals with the water from the machine top and bottom felt whipper showers.

The architects for the mill buildings and the main building contractor were Elliot, Cox and Partners, and Taylor Woodrow Construction, Ltd., while the consultant for the power station was J. D. Crozier and Partners, Ltd., and the contractors Holst and Co., Ltd. Pipework was carried out by Colvin-Smith, Ltd., and compressed air pipework by J. W. Cubbage and Son, and the electrical contractors were W. J. Furse and Co. (Manchester), Ltd., and F. H. Wheeler (Southern), Ltd.

Industrial Irradiation Laboratory

A new laboratory equipped for carrying out electron irradiation as a commercial service was opened at the Barton Works of Metropolitan-Vickers Electrical Company, Ltd., last week. The main equipment in this laboratory is a 4 MeV linear accelerator, which produces an electron beam scanning an area of about 12in by ¾in. Material to be irradiated can be carried past the scanner on a variable-speed conveyor system, or can be manipulated on a work holder having four modes of positional adjustment.

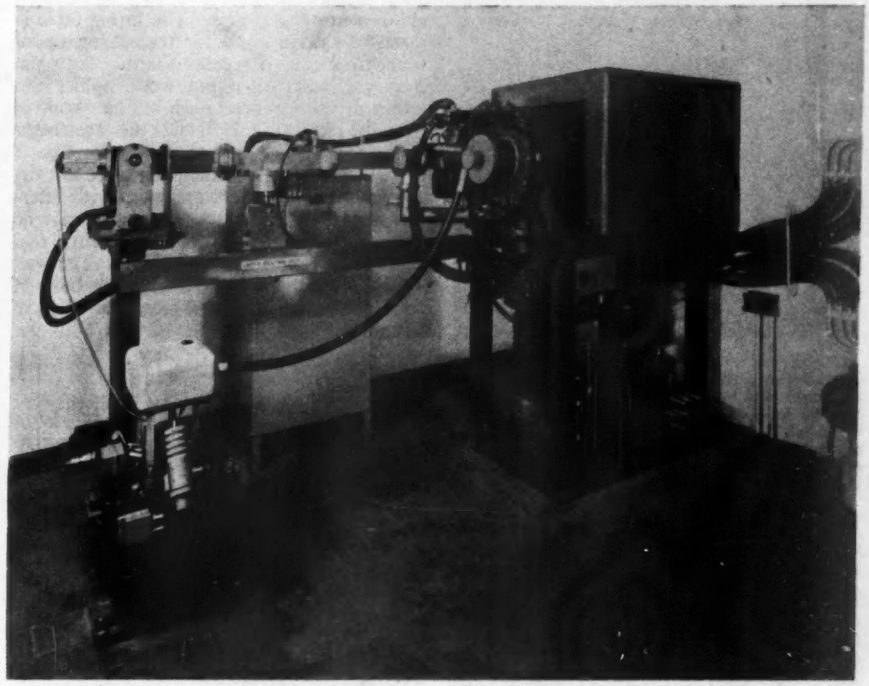


Fig. 1—4 MeV electron accelerator for irradiation. On the lower left is the pulse transformer; above is the magnetron and rectangular waveguide structure providing r.f. power to the corrugated accelerating waveguide housed in the cylindrical tank (upper right). In the framework below this tank is the vacuum pumping equipment

A COMMERCIAL service offering electron irradiation as an industrial process is available in a new laboratory which has been built and equipped at the Barton Works of Metropolitan-Vickers Electrical Company, Ltd., about 2 miles from the company's main works at Trafford Park, Manchester. Initially interest is likely to be focused on certain applications for which the advantages of irradiation have already been demonstrated. Typical applications are: the disinfestation of grain; preservation of foodstuffs; sterilisation of pharmaceuticals, dressings and sutures; curing of rubbers; the processing of plastics, including polymerisation, cross linking, chain scission and graft polymerisation. For these, and for any other applications that may arise, the laboratory service will provide for specific investigations, without involving clients in the purchase of equipment and the maintenance of trained staff. A limited amount of contract work can also be undertaken. Programmes of research and trial irradiation in the field mentioned above have been carried out, for a number of years, by the Metropolitan-Vickers Research Department on behalf of interested organisations, who have co-operated on the basis of exchange of information.

This laboratory is equipped with a 4 MeV linear accelerator in which electrons emitted from a diode are accelerated under vacuum along a corrugated waveguide by radio-frequency power generated in a pulsed magnetron. An important principle in the operation of the accelerator is the use of r.f. feed-back, the idea being that some power from the output end of the corrugated waveguide is fed back by a "door-knob" transformer, through a rectangular waveguide with a phase shifter, to an r.f. bridge (or "rat-race") where the power augments that from the magnetron and increases the efficiency of the operation. On leaving the accelerator the electrons have energies of about 4 MeV and a mean output of about 1kW is available. To make the best use of the concentrated beam vertical scanning is employed, the scanning tube being shown in Fig. 3.

The 4 MeV accelerator illustrated here is a direct descendant of the 8 MeV Metropolitan-Vickers linear accelerator which was installed in the Hammersmith Hospital, London, in 1950, and was the first in the world to be used for X-ray therapy. This machine was described in some detail in our issue of October 30, 1953, page 554. The 4 MeV accelerator which is the subject of the present article is similar in principle to the 8 MeV machine, but is much smaller and the physical arrangement is simpler. One difference is that, in the 4 MeV machine, the corrugated waveguide, which can be seen on the right of Fig. 1, is horizontal, and that the emergent beam is also horizontal, as can be inferred from Fig. 3. The hose connections, which can be seen entering the casing of the corrugated waveguide on the right of Fig. 1, provide two water-cooled circuits: one is for the waveguide focus coils, which carry a current of

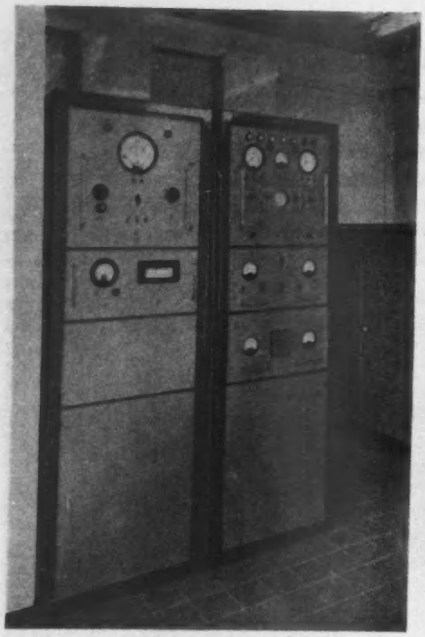


Fig. 2—The control station. The conveyor system, work table and beam scanning current are controlled from the left-hand cubicle, which also houses the focus coil supply for the accelerator and gives an indication of the mean current in the electron beam. In the right-hand cubicle are the controls for operation of the irradiation machine itself. In the background is the modulator cubicle

about 300A, and the other for the waveguide structure itself, in which losses of the order of 1kW are generated.

A beam scanner with an output window of pure aluminium foil is fitted to the accelerator and can be seen on the left of Fig. 3. Accordingly, the beam can scan an area of 12in (vertically) by ¾in at the window. Greater areas can be covered either by adjusting the position of the scanner and accepting some loss of intensity, or by passing the material through the beam several times with a fresh area presented to the beam at each pass.

Two separate motor-driven systems are installed for the handling of material during irradiation. One is a conveyor system whereby the work is passed in front of the electron beam. The other is a work holder (Fig. 4) giving the specimens four degrees of freedom—movement along rectangular co-ordinates in the horizontal plane, rotation about a vertical axis and tilting, or rotation about a horizontal axis. The tilting table is made of slotted angle for the setting up of small articles of irregular shape. Both the conveyor and the tilting work holder are motor-driven under push-button control from the panel (Fig. 2) outside the accelerator room. The other panel shown in Fig. 2 carries all the operational controls for the accelerator. All doors are fitted with interlocks to ensure that the equipment can be made safe before the treatment and accelerator rooms can be entered. The wall surrounding the radiation areas are built of thick concrete with a steel facing 4in thick in certain positions.

Some Particulars of the 4 MeV Linear Accelerator

Electron beam :	
Electron source	Diode
Accelerating potential	10–40kV
Mean beam current	125μA
Scan frequency	10 c/s
amplitude, above and below mean	6in
Mean power output	1kW
Pulsed power :	
Source, magnetron with frequency-pulling by phase-shifter and r.f. probe	
Frequency	2998 Mc/s
Pulse width	2μs
Pulse repetition frequency (p.r.f.)	50–500 per sec
Power measurement by r.f. wattmeter with 2 Pt. probes ¼ wavelength apart	
R.f. bridge ("rat-race") gives 1 : 1 power recombination.	

TABLE—*Typical Cost of Irradiation Using a 4 MeV 600W Linear Accelerator*
Based on a Hire Charge of £50 per 8-hour day

Process	Typical Dose	Estimated Utilisation	Capacity of 600W machine	Approximate cost of treatment
Prevention of sprouting in potatoes	10,000 rads	50%	11 tons/hour	11s. 9d./ton
Disinfestation of grain	50,000 rads	80%	3·36 tons/hour	37s./ton
Preservation of foodstuffs	50,000 rads	45%	4,320 lb/hour	¼d./lb
	0·5 megarads	45%	432 lb/hour	4¼d./lb
Sterilisation of drugs, &c.	2 megarads	80% (in bulk)	192 lb/hour	7½d./lb
		5% (in phials)	12·0 lb/hour	10s./lb
Curing of rubbers	5 megarads	80% (in bulk)	77 lb/hour	1s. 8d./lb
		20% (mouldings)	24 lb/hour	5s. 3d./lb
Treatment of plastics	25 megarads	80% (in bulk)	16 lb/hour	8s./lb
		25% (mouldings)	5 lb/hour	25s./lb

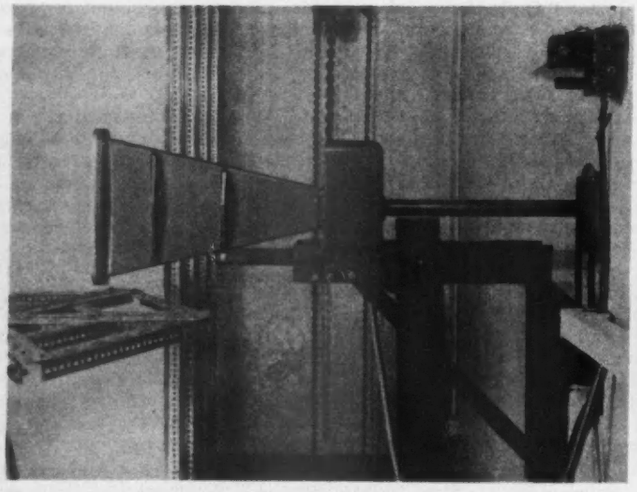
APPLICATIONS

Specimen costs of irradiation are given in the accompanying table on the basis of the typical doses quoted for each of the processes. The unit of irradiation dose is the rad which is defined as the dose received when 100 ergs of energy are absorbed per gramme of the material. Dose ranges, however, cover several decades and for many applications the rad is inconveniently small and the megarad (=10^6 rad) is more suitable. The megarad represents an absorbed dose of 10 joules (or 10 watt-seconds) per gramme of material.

These figures are based on the assumption that the conveyor system and beam scanning arrangements are adjusted to give the most efficient use of the machine.

Among the interesting irradiated specimens that we saw during a recent visit to the irradiation laboratory at the Barton Works were examples of the controlled vulcanisation of silicone rubber. They included a section of the stator bar of a turbo-generator insulated with glass tape/silicone rubber. Full cure was effected in ten minutes with irradiation of 5 megarad, without chemical treatment or heat, whereas the normal curing process would involve holding the insulated stator bar at a temperature of 200 deg. Cent. for two days. Moreover curing by irradiation left the copper surface completely free from oxidation.

Another specimen typifying the work done at Barton was a section of a high-power, low-loss television feeder cable, consisting of a copper conductor supported by a polythene helix. Irradiation of such a cable raises the softening point of polythene and reduces the creep and, therefore, makes the cable suitable for higher operating temperatures.



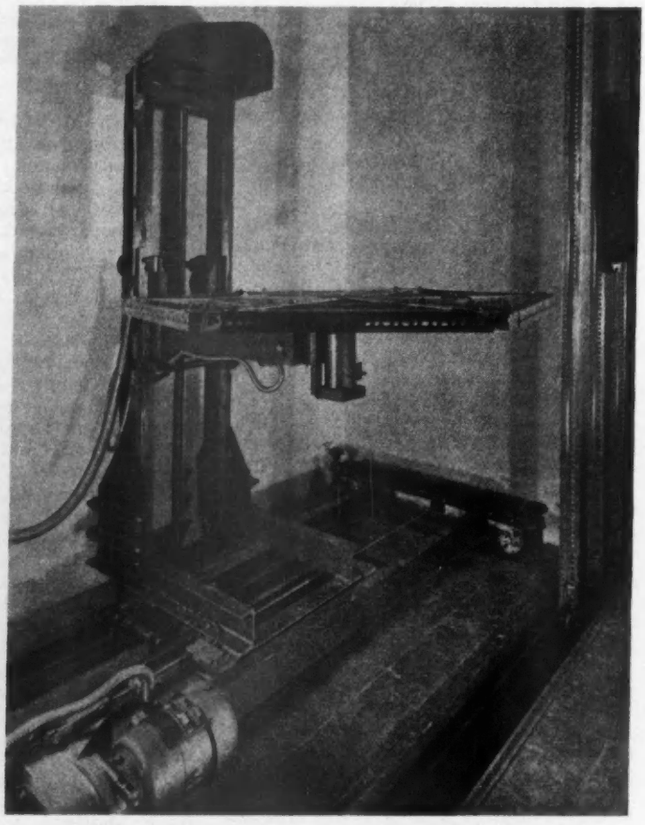
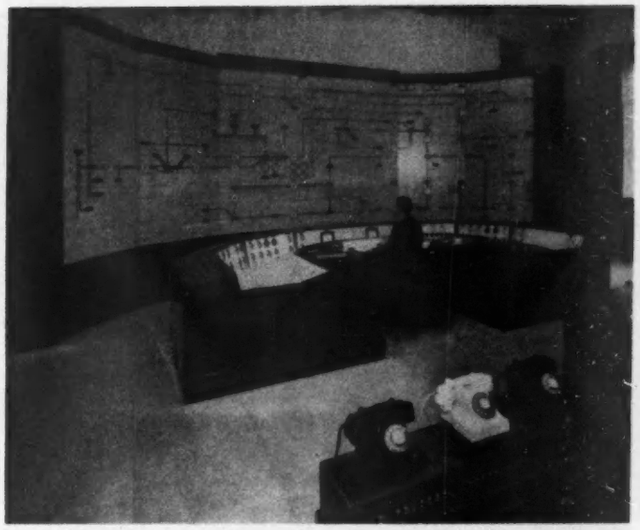


Fig. 3 (Left)—Electron beam scanner and work holder. Beyond the wall on the right is the accelerator shown in Fig. 1. Fig. 4 (Right)—The motorised work-holding table, which provides for vertical lift, traverse and rotation in the vertical and horizontal planes. The table can be controlled both from outside the treatment cell and locally for setting up. The turntable is made of slotted angle

Grid Control Centres



A standardised system has been developed for the control centres through which the British Grid with its 260 power stations (having a total generating capacity of 22,000MW) and 350 main switching stations, are operated as a single unified system. An outline of the new scheme, together with its historical background is given here, and the control centre at Bristol is illustrated on the right.

ON a visit to one of the new Grid control centres last week, we saw how the operation of the Central Electricity Generating Board's electricity supply system is co-ordinated. This system, the British Grid, is the largest supply network under unified control in the world. It consists of 260 power stations with a total generating capacity of 22,000MW and 350 Grid switching stations, the whole system being connected through the Grid and operated as a single entity so that those power stations that can generate most cheaply are used to the maximum (base load) and the stations where the generation costs are higher are used as little as possible (peak load).

For this unified operation there are, in England and Wales, seven Grid control centres—Newcastle, Leeds, Manchester, Birmingham, Bristol and London (two)—each in direct communication with all the power stations and main switching points in their area and a national control in London which is in direct control with the Grid control centres.

Twenty-four hours a day this system control organisation is checking costs of generation, planning generating programmes and issuing instructions for generating plant in power stations to be started up or shut down so as to meet the constantly changing demand for electricity at the lowest possible overall cost. To do this as effectively as possible, the original Grid control centres that have existed for twenty to twenty-six years have recently been superseded by modern centres embodying up-to-date techniques and apparatus using communication and indicating equipment which is standard throughout the country.

It may be recalled that twenty-six years have elapsed since the Grid system was first put into operation by the Central Electricity Board. For control purposes the country was divided into seven districts, with combined Grid control centres (G.C.C.s) and district headquarters in London, Bristol, Birmingham, Manchester, Leeds, Newcastle and Glasgow, respectively. The Grid control areas remain substantially the same to-day, except that in 1950 the South East Control Area was subdivided into "Thames North" and "Thames South" control areas and served by the then London control centre; and with the commissioning of the 275kV Supergrid at Carlisle, control of the Westmorland and Cumberland regions has been transferred to Newcastle. The control areas were operated as separate systems until 1938, since when they have been operated as a single national interconnected system, with the G.C.C.s under the co-ordination of a national control centre in London. Since 1955, the Grid in Scotland has been operated independently, but in liaison with the national control centre.

In the early 1930s, no less than five differing systems of general indicating, telephone and telemetering equipment were to be seen in the various control areas. They used rented P.O. lines from the power stations in the control area to a central trunk exchange and thence to the G.C.C. in the suburbs. Signals were automatically transmitted from the stations to indicate the functional condition of circuit-breakers and the tap positions of the on-load tap-changing transformers. Communication with the G.C.C. and district headquarters was provided from special telephones in the Grid switching stations and associated power stations, which at that time were owned by power companies and town corporations. Power station control rooms also had instruction indicators which responded to any of seven instructions transmitted by the G.C.C. control engineers. In Birmingham, continuous telemetering was used, but elsewhere information was transmitted by "on request" systems. The telemeters indicated the active and reactive power transfers through the Grid transformers and on the inter-area feeders; they also indicated power station total MW generation from transmitters hand set by the power station operators. "On request" telemetering of inter-area transfers was soon displaced by continuous telemetering systems. The first Grid feeder flow diagram was commissioned in 1937 at the national control centre to display on a national scale the power transfers between the different control areas.

Need for Standardisation

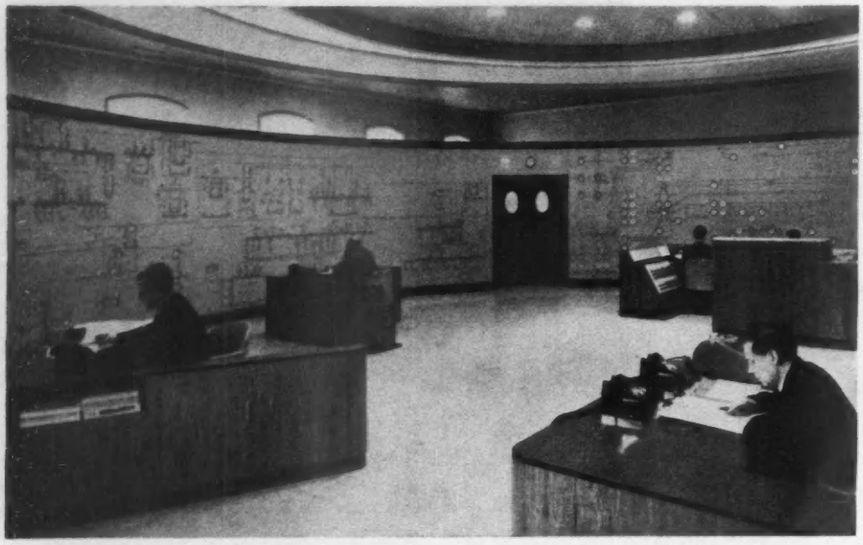
As the Grid expanded, particularly during the war, individual installations had to be modified from time to time and the cost and engineering effort expended emphasised the need for a readily extensible and standard system for general indications, telephones and telemetering. Matters came to a head in 1948, when the supply industry was nationalised, and it became necessary to provide communication facilities between the generating stations and the respective headquarters of the fourteen Generation Divisions of the British Electricity Authority. A year later it was decided to re-equip the fifteen-year-old Grid control networks with a standard system of general indicating, telephone and telemetering equipment, which could be extended from time to time to suit changing conditions. The installation of a "standardised system," as it came to be known, was authorised in all generating and Grid stations and most supply points to the Area Electricity Boards. Because of congestion at the existing G.C.C.s, and with recollection of wartime experiences, it was decided to build new and larger centres in more suitable districts.

The Standardised System

The British Electricity Authority (as it was then called) and the telephone manufacturers concerned—the Automatic Telephone and Electric Company, Ltd., The General Electric Company, Ltd., and Standard Telephones and Cables, Ltd.—set up a telecommunications technical committee (T.T.C.) to plan and design the "standardised system." Because of the complex variety of stations and network conditions, the standardised system could not be a specific installation with universal application. On the other hand a firm standardisation of many different items of equipment which could be installed in different combinations to suit the requirements of different stations was practicable. When sufficient items had been codified, and the planning parameters of the new system determined, the Authority was able to plan the new Grid control networks and issue the various contract specifications. It was decided to continue using rented Post Office lines because over the fifteen years they had proved to be satisfactory and there was, and even to-day there is, no better alternative.

In the "standardised system" the stations in a Grid control area are considered as being either major stations or minor stations. A major station is usually a generating station either with or without a Grid switching station, or is a large attended Grid switching station not associated with a generating station. Only the major stations are equipped to send signals to or receive signals from a G.C.C. A major station usually has a direct line to the G.C.C., in which case it is termed a radial station, and has also a direct line to each minor station associated with it, usually not more than three or four. A minor station is usually a small Grid switching and transforming station or a bulk supply point to an Area Board. A minor station can only send signals to or receive signals from a major station.

For economy in rented circuits the more distant major stations are connected in



Control room of the new Thames North Grid control centre near St. Albans. One of the two switching desks is on the left facing the mimic diagram. The loading desk, right background, faces the feeder flow diagram

groups, usually of two, but up to a maximum of four stations. A group is served by a common line from the G.C.C. to the nearest or most important station in the group and from this parent station by separate lines to each of the satellite major stations in the group. Pairs of major stations served by separate lines to the G.C.C. are interconnected by tie lines to provide an alternative although indirect means of communication with the G.C.C. The more important radial stations may have second lines to the G.C.C. which are switched to take over service should the normal line fail. In everyday use reserve lines operate as inter-PAX tie lines between the G.C.C. and the stations.

A new network is being provided for the full scale transmission of general indications, telephony and telemetering to a new national control centre in London from the various G.C.C.s and will provide communication and standby telemetering facilities between the South of Scotland Electricity Board's G.C.C. at Glasgow and national control. This network will also give direct communication between the G.C.C.s and connect with standby national control centres. The Post Office teleprinter network between national control and the G.C.C.s will be retained to reinforce the new network.

Grid Control Rooms

A different layout of equipment is adopted for each of the G.C.C. control rooms, but this departure from uniformity does not affect the "standardised system."

Mosaic switching diagrams, which have proved satisfactory for 20 years, are used.

Feeder flow diagrams were first used at national control in 1937. They incorporate telemeters in mimic power lines to indicate the magnitude and direction of active and reactive power flow in the various 275kV power lines and transformers and in the majority of the 132kV lines. In each line a red lamp flashes when the current exceeds a preset value, while at the line ends green lamps light whenever the switchgear opens the line. A typical feeder flow diagram has about 100 telemeters.

Facing the switching diagram is a control desk for each of the two switching engineers. They are equipped with keyboards for calling or answering any control telephone in the area with overriding priority over inter-office traffic. On the loading desk, which is in front of the feeder flow diagram and usually has accommodation for two engineers, chart recorders indicate area net transfer, area total generation and system frequency. Other instruments indicate rate-of-change of system frequency and daylight intensity as telemetered from the main industrial load centre of the area. The loading desk also incorporates a sixteen-way message instructor for the various out-stations and on an adjacent console there are individual power station MW generation instructors.

Each power station control desk has a control telephone and local telemeter indications similar to those telemetered to the G.C.C. of the stations' total generation in MW "sent out" and "gross" MVAr. There is also an indicator which responds to the G.C.C. loading engineer's generation instructions, and combined lamps and twist buttons for the display and acceptance of visual instructions transmitted by the G.C.C. loading engineer and a button to relight the last instruction received.

Attended transmission stations can be provided, if required, with systems of visual instruction for effecting load reduction and restoration. Unless they are remotely controlled by the Area Board concerned, unattended minor stations are controlled through the standardised system over the Grid control network by the Generating Board from the associated major stations which are usually generating stations and therefore attended. As a precaution against rented line failure, however, this method of control is reinforced at the minor stations by automatic reclosure of the Grid circuit-breakers.

Design D.C. Signalling.—As already mentioned the standardised system continues the established practice of using rented G.P.O. lines as the main channels of communication. Lines between stations and G.C.C.s can be up to 150 miles long, but usually they are short enough to allow earth-return d.c. phantom signalling, which is inexpensive and does not interfere with speech or voice frequency telemeter signalling. It is unaffected by line reversal and at stations where isolation is not required the earthed positive pole 50V station batteries are used for line signalling. As this system precludes the polarising of signal train marking impulses they are marked by increasing the make period from 50 to 160 milliseconds. Unmarked pulses are transmitted at a rate of ten a second with equal make and break.

Tone Signalling and Speech.—On lines where d.c. earth return signalling cannot be used the established practice of using 300 c/s tone signalling is retained, with the speech band restricted at the lower end to 400 c/s and interrupted 480 c/s for the ringing and busy tones. This system is employed between G.C.C., parent and satellite stations to minimise impulse distortion on signal trains relayed by parent stations and because inter-station dialling between parent and satellite stations requires the d.c. channels. The speech band is also restricted to an upper limit of 2000 c/s to allow the simultaneous transmission of speech and telemetering at 2220 and 2340 c/s.

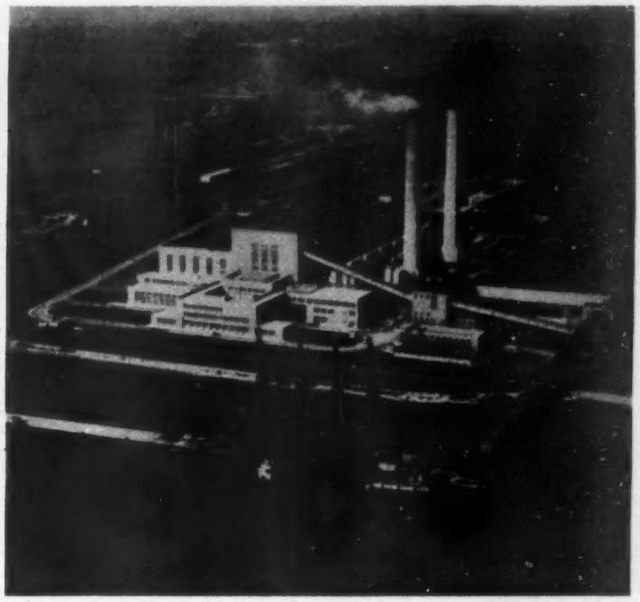
Instruction, Indication and Telephone Signalling.—From the G.C.C.s the d.c. or 300 c/s signalling channel is used to select visual messages or generation instructions at the stations and to set up telephone calls. The same channels are used from the stations to signal telephone calls and the indications of circuit-breakers, automatic isolators, overloaded feeders, direction (import or export) of telemetered power transfers, loss of telemeter channels between stations and acknowledgment of visual message instructions. To prevent lock-out due to channel congestion during heavy traffic, the selection, indication and telephone signal trains use the common signalling channel in turn.

When an indication train is transmitted from a satellite station it is relayed to the G.C.C. by the parent station, which, together with the other satellite stations, is then prevented from sending an indication train. With an additional group selection code, selection trains from the G.C.C. are relayed by the parent station into the local equipment or to the selected satellite station. The telephone system used in the "standardised system" is very comprehensive and incorporates many innovations and facilities to enable it to meet operational requirements.

Telemetering.—When more telemeters were required in the early 'forties, telemeters which required individual signalling channels were superseded by multiplex systems. They served their purpose, but it was evident that telephone relays were not satisfactory for continuous multiplex operation. Accordingly, an electronic multiplex telemetering system was adopted in the "standardised system." This uses start-stop time division with 20 milliseconds marking and scans ten meters in 200 milliseconds three times a second. In the G.C.C.s the decoded impulses operate electronic telemeters to produce d.c. voltages directly proportional to the impulse rates. Indications of the direction of telemetered power flow are transmitted by the general indicating system as a point indication, which allows the full capacity of the multiplex system to be used.

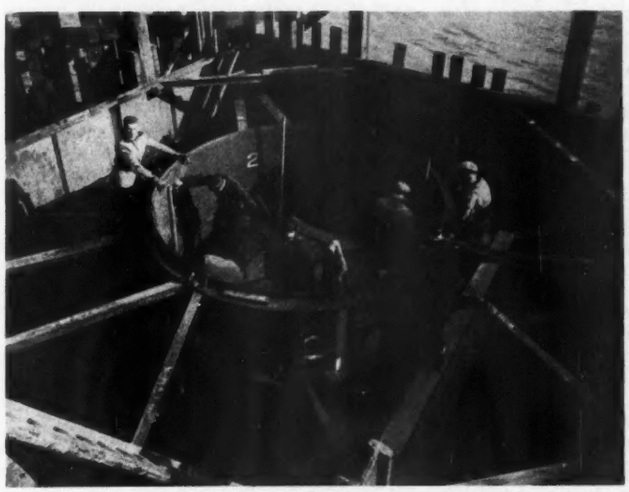
Intertripping of Grid circuit-breakers between Grid stations using the control networks was introduced in 1934. The original systems were low speed (0·8 second) and became outmoded when the use of automatic 132kV fault throwers to clear transformer and l.v. faults was approved, provided the fault level did not exceed 500MVA. However, intertripping was still required in some situations and a number of high-speed systems have been installed during the last five years. A recent development provides for the transmission of signals, initiated by high-speed line protection, to accelerate the operation of remote distance protection equipment or to unlock inhibited directional overcurrent relays at remote transformer feeder stations.

Tilbury Power Station



Tilbury power station is being officially opened to-day, Friday, June 6, by Colonel Sir Francis Whitmore, Bt., Lord Lieutenant of Essex. The station has six 60 MW units, the last of which incorporates a prototype water-cooled stator. Complete conversion to oil-firing is planned, though at present only two of the boilers are oil-fired. The steam conditions are 950 lb per square inch and 925 deg. Fah. and the thermal efficiency is about 30 per cent.

THE power station at Tilbury, which is being officially opened to-day by Colonel Sir Francis Whitmore, Bt., was originally planned for nine power units (negotiations for the site began in 1947). Offices, workshops, &c. have been provided on a scale to suit the final larger station, but the generating plant at present consists of six units. The first unit was commissioned in September, 1956, and the sixth in December, 1957. The extension will certainly be built in time, it is thought, but the programme of work does not include this item yet. It is to be built downstream of the present station on land which is now undeveloped.



The circulating water inlet caisson was made at ground level and then sunk to the foundation 60ft below ground level by excavating within the sealed structure under compressed air. The picture shows the caisson under construction

The station is neatly laid out. Considerable flexibility in operation has been achieved, and we understand that advantage has frequently been taken of the ability to assume or shed load quickly. Current is supplied to the 132kV grid and 275kV supergrid.

It is intended to convert entirely to oil-firing in 1958, but four of the units are still coal-fired. Research on the behaviour of the oil (supplied from Fawley) is being carried out, and various additives are being tested. Solid fuel is being pulverised in ball mills which are reported to be quite satisfactory : the supply of steel balls is made up at intervals.

Building and Civil Engineering

In addition to the access road and railway, a reinforced concrete bridge across the Tilbury–Southend railway was included in the first civil engineering contract. The foundations of the power station are all built on precast reinforced concrete piles, of which about 13,000 (averaging 55ft in length) were driven. All the buildings have steel frames and are clad in London stock brick. The reinforced concrete of the 330ft chimneys is coloured to harmonise with the brick. A reinforced concrete jetty, 400ft long, has facilities for unloading ocean-going colliers. The 300ft upstream arm of the jetty is arranged to accommodate plant for loading ash into sea-going barges. The fine ash dust is at present being mixed with water to make a "porridge" which is being used to fill in the site : a layer of topsoil will eventually be brought in to cover this.

A major task was the construction of the circulating water system. This consists of a water tunnel, 11ft 8in in diameter, from a vertical intake under the jetty to screen and pumping chambers behind the river bank. These chambers were built inside a caisson 118ft by 76ft. The caisson was made at ground level and sunk to the foundation 60ft below ground level by excavating within the sealed structure under compressed air at 40 lb per square inch. Men and material had to pass through airlocks.

Two reinforced concrete underground culverts, 7ft square, connect the pump and turbine houses. Circulating water from the main condensers passes through twin outlet culverts, shaft and tunnel to the river bed upstream of the intake.

The size of the coal-handling plant was chosen to allow for the second station mentioned above. The plant is designed to deal with fuel delivered by 4500-ton colliers. Coal is unloaded by four cranes (see title illustration) rated at 200 tons per hour maximum, which deliver to belt conveyors (400ft–475ft per minute). Coal is spread or reclaimed from store by a travelling transporter with a travelling grab capable of up to 800 tons per hour. The maximum capacity of the grab is 320 cubic feet. Each of the bunkers over the six boilers can take 730 tons.

Two welded tanks, 120ft diameter and 46ft high, store 14,500 tons of oil each. Hot-water heaters keep the contents at 150 deg. Fah. The water is heated in three auxiliary boilers, each rated at 12×10^6 B.Th.U. per hour, 250 lb per square inch, 400 deg. Fah. Two rotary oil-burners, arranged for automatic and remotely controlled operation, are fitted per boiler.

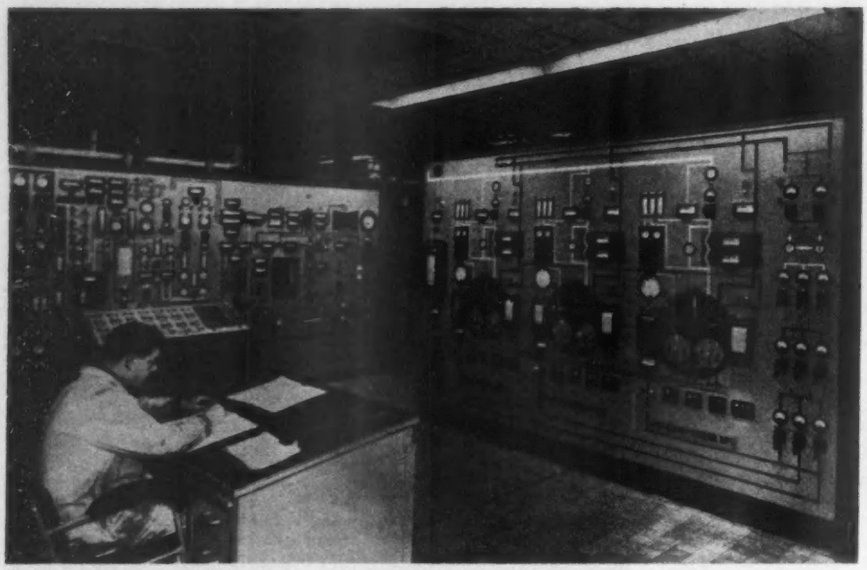
Pipework and pumps are provided to take oil from 5000-ton tankers at the jetty and supply 70 tons per hour to the boiler-house ring main at 50 lb per square inch.

Boilers

One boiler is connected to each turbine. Coal falls from the bunker through weighers and mill feeders to two ball mills that pulverise it at a rate of up to 17 tons per hour. The fuel then proceeds through variable-speed fans (three per mill) to twelve turbulent burners in the rear wall of the combustion chamber. Air for combustion is taken from above the boiler by two forced-draught fans and passed through rotary regenerative heaters. The latter are fed with flue gas from the boiler. Some of the heated air goes to the mills where it helps to dry the coal. Hot gases from the furnace pass through a self-draining superheater, a plain-tube economiser and two rotary air heaters. Dust is extracted mechanically and electrostatically before the gas is removed by induced-draught fans to the chimneys.

For oil firing each of the twelve pulverised-coal burners and their connections is replaced by an oil burner. Two pumping and heating units raise the pressure and temperature of the oil for each boiler to 500 lb per square inch and 280 deg. Fah.

The boilers are automatically controlled, whether coal- or oil-fired. Evaporation is at



One of the air-conditioned control rooms in which the panels for two generating units face each other. In the case illustrated there is a third panel (in front of the operator's desk) for the three auxiliary boilers. Closed-circuit television is used on all panels to indicate water level. Double glazing helps to exclude noise from the rooms

540,000 lb per hour for a heating surface of 33,770 square feet. Superheater, economiser and regenerative air heater surfaces are 19,050, 18,340 and 234,000 square feet respectively. The steam conditions are 950 lb per square inch and 925 deg. Fah.

Turbines

Each boiler and turbine is an individual combination controlled from a single panel. These panels are in three separate air-conditioned control rooms on the operating floor between the boiler and the turbine. Line diagrams on the panels clarify the fluid circuits. Closed-circuit television is used to indicate water level. The six 60MW sets run at 3000 r.p.m. The turbine is a three-cylinder machine with a double-flow exhaust. The first trio consists of impulse-reaction, and the second of pure reaction, turbines.

Condensate from each unit goes through five-stage heating by bled steam before returning to the boiler at about 385 deg. Fah. at the maximum rating. Two main three-stage steam-operated air ejectors (one a standby) maintain vacuum. There is an extra, rapidly acting, ejector for starting.

The mechanical governors operate through oil relays. The main oil pump, which supplies both the governors and the bearings, is driven off the turbine shaft. An auxiliary pump driven by an a.c. motor serves during starting and stopping: this cuts in automatically if oil pressure drops. Other devices for the protection of each turbine are provided in the usual way.

Alternators

The alternators generate at 11·8kV and the output is transformed to 132kV. All but one of them are orthodox in design, cooled by hydrogen at 0·5 lb per square inch; the hydrogen is passed through coolers from which the heat is taken by distilled water and then transmitted to circulating water. The sixth alternator is of particular interest, however, having a water-cooled stator. It is a prototype from which experience will be gained for the design of future machines putting out 275MW and more. Water cooling is to be used in certain 200MW alternators being made for the C.E.G.B. Water is, of course, a much better coolant than gas, but when in direct contact with high-voltage conductors it must also serve as a good insulator; this it will do, provided that it is sufficiently pure.

In the present case the water flows through all the conductors in parallel from one end of the winding to the other. The conductor strips are transposed in the slot portion, and each end of the conductors is solidly brazed to special ferrules, water being supplied to the latter. To avoid the connection of a number of flexible metal or insulating hoses to the ends of every conductor (with two conductors in each of sixty slots there are 240 ends altogether), the ferrules are made to terminate in water boxes moulded from epoxy resin. Two water boxes per phase are provided, making a total of six at each end of the stator. The potential difference across the water column in each box is therefore half the phase voltage, and losses are small. The leakage currents between all adjoining end connections are much the same because the potential differences are fixed by the winding voltages. One main connection is needed for each water box; these are joined to common inlet and outlet pipes at the base of the two ends of the casing. Gas bleeds are provided at the highest point of each box: they lead to external collecting chambers, each fitted with a detector that operates an alarm if gas appears. Nuts fix the conductor ferrules to the water boxes, and O-rings seal either side. Channels in the wall of the box, between the seals, are connected to the secondary stage of the pressure regulators on the hydrogen supply manifold. Gas at about 10 lb per square inch more than the pressure in the casing (itself higher than the water pressure at any point) can therefore be fed between the two seals to provide an additional safeguard, though it is claimed by the maker that there has been no difficulty in practice in making the boxes watertight. The ends of the conductors are connected inside the water boxes by clamps with silvered contact faces, and the rise in the temperature of these links is said to be very low: no further brazing is needed after assembly of the windings. Distilled water is circulated by a pump that absorbed 4kW during the maker's tests on the system. A small demineralisation plant is added, though experience with hydrogen coolers elsewhere has indicated that deterioration of the distilled water is unlikely.

Ash and Dust Handling Plant

Clinker from the hoppers below the boiler furnaces is sluiced away at a rate of up to 45 tons per hour by four high-pressure pumps, each delivering 2500 gallons per minute, to a pit at the rear of the station. Dust from the hoppers of the extractors is removed pneumatically to 720-ton bunkers outside each end of the boiler-house, and watered during discharge into lorries.

Water Systems

Cooling water is drawn from the river below the coaling jetty, flowing through six vertical band screens. It is then delivered by six vertical spindle pumps—each with a capacity of 42,000 gallons per minute—into the underground culverts from which connections are taken to each of the six condensers. Chlorine is introduced into the circulating water at points adjacent to the inlets of the condensers.

To provide pure water suitable for filling the boilers and making up the losses, town water is first softened by a hydrogen ion base exchange blend process, followed by distillation in evaporating plants having a combined capacity of 4200 gallons per hour. The evaporators associated with four of the units have been designed to deal with saline river water, followed by final treatment in demineralisation units of the mixed bed type, thereby considerably reducing the consumption of town water.

Each unit is provided with three motor-driven feed pumps in the turbine house basement which deliver feed water to the boilers. Each of these pumps is rated at 50 per cent of the maximum demand.

Transformers and Switchgear

The main generator transformers are rated at 72MVA and raise the generator voltage to 132kV at full load. Each of these transformers is equipped with two fully rated coolers in which the transformer oil is cooled by water from the circulating water system. Adjacent to the main are two station transformers taking their supply from the 132kV switching station and feeding the 3300V auxiliary switchboards in the power station. A unit transformer is also connected to each generator and normally supplies the auxiliary power required for that turbine and boiler unit.

The main 132kV switchgear embodies air blast circuit breakers with a rupturing capacity of 3500MVA. This is outdoors, to the north of the generating station.

Main Contractors

Civil engineering works: Holloway Bros. (London), Ltd.; Walter Lawrence and Son, Ltd.; Alexander Findlay and Co., Ltd.; Tileman and Co., Ltd.; Bierrum and Partners, Ltd. Circulating water system: Drysdale and Co., Ltd.; J. Blakeborough and Sons, Ltd.; William E. Farrer, Ltd. Boiler plant: John Thompson Water Tube Boilers, Ltd. Instruments and Boiler Control: Electroflo Meters Company, Ltd. Turbo-alternators: English Electric Company, Ltd.; C. A. Parsons and Co., Ltd. Condensing and feed heating: English Electric Company, Ltd.; C. A. Parsons and Co., Ltd. Cranes: Clyde Crane and Engineering Company; Wharton Crane and Hoist Company, Ltd.; Herbert Morris, Ltd.; Reed Crane and Hoist Company, Ltd.; Stothert and Pitt, Ltd. Boiler feed pumps: Sulzer Bros. (London), Ltd. Coal handling plant: Mitchell Engineering, Ltd. Ash and dust handling plant: Babcock and Wilcox, Ltd. Pipework: Stewarts and Lloyds, Ltd.; John Thompson (Wolverhampton), Ltd. Air compressors: Broom and Wade, Ltd. Valves and mountings: Dewrance and Co., Ltd.; Hopkinsons, Ltd.; J. Blakeborough and Co., Ltd.; Sir W. H. Bailey and Co., Ltd.; Saunders Valve Company, Ltd. Water treatment plant: Permutit Company, Ltd. Fuel oil storage tank: Clayton, Son and Co., Ltd. Auxiliary boilers: Mather and Platt, Ltd. Transformers: English Electric Company, Ltd.; Brush Electrical Company, Ltd. Switchgear: Metropolitan-Vickers Electrical Company, Ltd.; English Electric Company, Ltd. Control room equipment: Standard Telephones and Cables, Ltd.; English Electric Company, Ltd.; General Electric Company, Ltd.; Metropolitan-Vickers Electrical Company, Ltd. Conversion to oil firing: John Thompson Water Tube Boilers, Ltd.; Hamworthy Engineering Company, Ltd.; British Combustion Equipment, Ltd.; Aish and Co., Ltd.

SHORTER REPORTS

Nuclear Power Station at Dungeness

IT has been announced that the Central Electricity Generating Board is seeking permission to use a site at Dungeness, Kent, for its fifth nuclear power station. Approaches have been made to the Ministry of Power and to the local planning authority. It is stated that the site, which is immediately west of the lighthouse near the top of the Dungeness promontory, has been shown to be admirable for the purpose in mind. There is deep water close inshore, and this is thought to provide "exceptional facilities for the vast quantities of cooling water required." Trial bores are reported to have shown that heavy reactors (presumably two in number) can be supported on the site, which consists of shingle and does not encroach on agricultural land. Space would be left for further development later.

The station would be able to put out between 500MW and 550MW and would be connected to the 275kV transmission system. (The latter is now being brought to Lydd to connect with the French system through a cross-Channel cable.) The project may be compared with the four nuclear power stations already being built in the United Kingdom, three of them for the C.E.G.B. and another for the South of Scotland Electricity Board. These stations are at Berkeley, Gloucestershire (275MW), Bradwell, Essex (300MW), Hinkley Point, Somerset (500MW), and Hunterston, Ayrshire (320MW).

Radar Simulator

UNDER watch-keeping conditions navigational training is extended over a long period and even then situations may develop which have not been encountered before, so that the necessary action to be taken is not readily carried out. The position is even more hazardous in fog and in darkness, and safe navigation is often dependent upon the rapid interpretation of radar information. Information is all that radar provides; therefore, if it is to be of value in producing the solution to navigational problems the officer concerned must have had training under conditions which simulate all those likely to occur at sea. It is not possible, because of the potential danger and the enormous cost, to reproduce actual problems at sea and, to surmount these difficulties, Ultra Electric, Ltd., has developed a marine radar simulator. The equipment enables the student navigator to carry out entirely by radar ship handling operations and the necessary manœuvres to avoid collisions. Every action taken by the student can be analysed subsequently and the controller, who can watch every stage of the exercise, can give guidance and also advise upon the correct action which should be taken under any particular set of circumstances. The simulator makes it possible for classes to be instructed and for students to carry out exercises set by an examining officer.

A number of basic units, each of which provides a particular facility, are incorporated in the simulator and systems can be formulated to meet specific requirements. Artificially generated radar signals, controlled by an instructor, present radar evidence of ships, aircraft, coastlines and other fixed objects, and these have to be interpreted by the student operator. The latter will order the changes in course and speed, which he calculates are necessary, just as if he was on the bridge of a ship. Assisted by compass and speed indications repeated from the controller's console, the student will see the results of his orders on his display screen. The alterations will not be immediately visible since an inertia period provides for the delay which normally occurs in the response of a ship to changes of course and speed. Repeater indicators keep the student informed of his own vessel's speed and heading. The controller may introduce up to six target ships and also has facilities for displaying echoes of coastlines and other geographical characteristics.

Among the basic simulator units is a realistic motion computer for use as the radar parent ship and it computes "northings" and "eastings" of the speed and rate of turn and imparts realistic delay in response to helm and speed orders. A simple motion computer simulates radar target ship, and a relative position data computer deals with the "northing" and "easting" velocity vectors of parent and target ships, to determine the bearing and range of the target from the parent ship. There is an electronic unit which is responsible for the simulation of echoes and effects such as sea clutter, adjustment for earth curvature, and also a true motion unit. In the coastal mapping unit a photographic transparency is used in association with a flying spot c.r.t. optical system to generate realistic ground return radar signals.

The radar simulator is at present designed for feeding into standard "Decca" radar equipment and the system provides for a display stabilised to compass, a display stabilised to ship's head, and a true motion presentation of the positional movements of targets and of the parent ship.

Works Apprenticeship Scheme

THE main engineering activities of the Dunlop Rubber Company, Ltd., are carried out in a group of five factories at Foleshill, Coventry, where 5500 people are employed. The firm's products are many and varied and include disc brakes, pneumatic suspension systems, anti-skid units for aircraft landing wheels, de-icing equipment, and components for guided missiles, as well as very large numbers of wheels for motor vehicles and bicycle rims. We recently had an opportunity to see the way in which training is organised at the factories, where the variety of work in the different sections provides excellent facilities for an effective apprenticeship scheme.

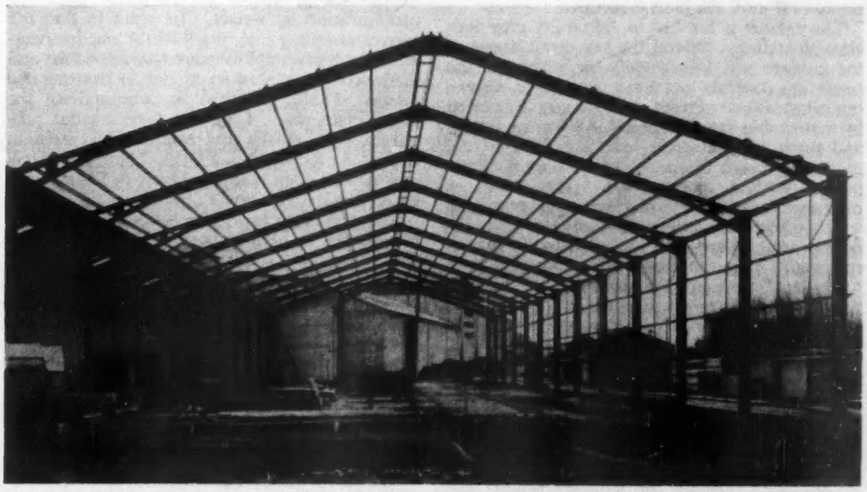
Each entrant, after spending his first month on some simple task designed to familiarise him with the organisation and working of the factory, spends periods of six months or more, depending upon his trade, in different departments. The scheme is essentially flexible and no fixed rotation of departments is followed. In the aero control instrument department training is given in the assembly and testing of hydraulic and pneumatic components. Experience in the manufacture of the components for these instruments and parts for disc brakes and aircraft brakes, is given in the complementary production machine shops. Tool setting practice in production is supplemented by the period in the toolroom where tools, jigs, gauges and press tools for the whole works are made and maintained. Training in the precision machining of individual components is carried out in a well-equipped school where the apprentices are given close individual attention over a period of six or twelve months. All the work produced in this school is for works use and is generally drawn from the toolroom, maintenance or prototype making sections of the works.

During his fifth and final year each apprentice normally spends his time in the department in which he will subsequently be employed. The trainee design draughtsmen and jig and tool draughtsmen, in addition to normal shop training, each spend some eighteen months in the drawing-offices. Whilst they are under training the apprentices attend Coventry or other technical colleges to qualify for the Higher National Certificate, Ordinary National Certificate and either the City and Guilds Final or Intermediate in Machine Shop Engineering. Some of the boys attend a three-year "sandwich" course of the Coventry Technical College for the Higher National Diploma. The apprenticeship scheme is organised for the training of 200 boys and it is of interest to note that some 95 per cent continue in the service of the company at the conclusion of their courses.

Steel Portal-Framed Building of 68ft Span

A TWO-BAY portal building has recently been completed by Sanders and Forster, Ltd., of Barking, Essex, at the Watford works of The Universal Asbestos Manufacturing Company, Ltd. The building, which we illustrate, was designed on the plastic theory, and is a development of the firm's tied portal design which was described in THE ENGINEER on April 29, 1955. The larger of the two bays has a 68ft span and is 240ft long. The smaller bay spans 33ft 6in and has a length of 190ft. The height to eaves is 20ft and to ridges 31ft.

The main frames, at 20ft centres, are so proportioned as to achieve the minimum weight of steel consistent with the use of rolled steel sections. The main eaves stanchions are 12in by 6in R.S.J.s and valley stanchions 8in by 6in R.S.J.s. The rafters on the main bay are 12in by 5in R.S.J.s and on the smaller bay 8in by 4in R.S.J.s. High tensile bolts are used for all site



Plastic design adapted to a portal frame gives the clean steelwork lines shown here. The design is based on minimum steel weight, using standard sections, bolted connections and a simple knee-brace

connections. A feature of the design is the introduction of the Vierendeel girder principle at the knees, where spaces within the knees can be used for internal services. The cladding is a sandwich construction comprising asbestos cement outer sheets, 1in glass fibre insulation and asbestos cement ribbed underlining, having a "U" value of 0·18 and "Unilux" translucent sheeting.

1kW, V.H.F. Transmitter

THE production of a new 1kW transmitter for v.h.f. communication systems is announced by Pye Telecommunications, Ltd., Newmarket Road, Cambridge. This "P.T.C. 3600 Transmitter" is designed mainly for ground-to-air working at airports and for teleprinter and voice-frequency links. It covers, continuously, a frequency range of 118 to 136 Mc/s. It consists essentially of two units, the radio-frequency and modulator sections, each assembled in a self-contained cubicle, the two cubicles being combined side by side into a composite equipment for R/T service, as illustrated.

The transmitter can be remotely controlled, and is protected against damage by overloads or maladjustments. In the event of a fault in the equipment or in the aerial system, a recycling protection circuit will switch the transmitter on

1kW, V.H.F. transmitter designed mainly for airport ground-to-air communications and for teleprinter and voice frequency links. The frequency range is 118 to 136 Mc/s

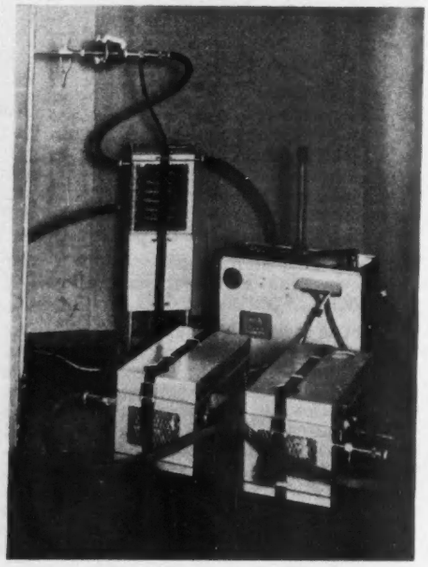
up to three times in succession, and if the fault persists after the third time the transmitter will remain off until the fault is rectified.

The cabinet is finished in Admiralty grey with chrome styling. Behind the two front doors of the cabinet are 19in panels on which all the operating controls are fitted, as can be seen in our illustration. Preset controls are concealed by removable front panels. All valves, relays and fuses are accessible from the front of the unit; there are doors at the rear to facilitate inspection and maintenance. The safety of operators is ensured by interlocking gate switches which disconnect dangerous voltages when the doors are opened or the detachable panels removed. All power supplies are provided with "bleeders" and, as a further safeguard, all high voltage condensers are automatically discharged when the front panels are removed or the rear doors opened.

Valves and components have been chosen for a standard of reliability which will enable the transmitter to be operated unattended in tropical climates. Forced-air-cooled tetrodes are used in the r.f. output stage and radiation-cooled triodes in the modulator. Filtered cooling air is circulated through the cabinets and is discharged by a fan at the top. All chassis are cadmium plated; transformers and chokes are vacuum impregnated.

Measurement of Dust Concentration in Gases

WE have recently received details of the sampling apparatus devised by the British Iron and Steel Research Association for rapid measurement of the amount of red iron oxide emitted with the hot waste gases from steel works. It is stated that the apparatus can also be used to measure coarse or fine dust from crushing, grinding, sieving, sintering or other processes. The method employed is to place a stainless steel probe in a stream of gas. The probe carries a sharp-edged nozzle which faces into the stream, and is so arranged that the sample collected by it enters with the same velocity (i.e. with the same speed and in the same direction) as the local undisturbed flow. This ensures that the dust content of the sample represents that of the gas stream where the probe



British Iron and Steel Research Association's apparatus for sampling corrosive gases and measuring their dust content. The gear has been applied to the fumes emitted from open-hearth furnaces, and is suitable for a number of other dust-emitting processes

is placed. The sample is drawn through a filter, the weight of which has been found, and is then cooled in a pair of coils to separate corrosive condensate. Two vane pumps in parallel expel the remaining fluid through integrating and flow meters. The difference between the new and the original weight of the filter gives the weight of the dust and fume in the sample, and division by the measured volume of the latter gives the concentration by weight. In order to find the correct sampling rate, the velocity and temperature of the gases are measured by pitot tube and thermocouple, placed so as not to obstruct the nozzle. Tables can then be consulted for the appropriate rate. (The full experimental procedure, with details and examples, is given in B.I.S.R.A. Report No. P/3/56, "Sampling Dust and Fume-Laden Gases in Ducts or Chimneys," by R. A. Granville and P. Ball.)

The arrangement of the sampling train with two pumps in parallel is stated to have proved very convenient. Two small pumps are better than a single larger one because the range of sampling rates proves wider and control is easier, as well as making for improved transportability. The placing of the meters downstream of the pumps is said to ensure that the volume and flow of the sample are measured at substantially constant temperature and pressure. Concentration is therefore found in terms of standard volumes, permitting the simple procedure described above.

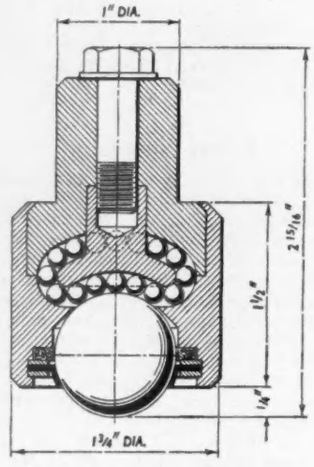
We understand that the original hand-made apparatus produced by the Physics Department of B.I.S.R.A. has been redesigned in collaboration with the Longworth Scientific Instrument Company, Ltd., Thames Street, Abingdon, Berks. This commercial model should collect a measurable weight of dust in a short time (often less than five minutes) and be ready for another within a minute. Expendable filters, made of graded glass fibres, are to be held in a stainless steel canister. It is stated that they will remove iron oxide fume from corrosive gas at 300 deg. Cent. at a rate of 3 cubic feet per minute.

Universal Ball Castor

THE drawing we reproduce below shows the construction of a design of universal ball castor developed by Autoset (Production), Ltd., Stour Street, Birmingham, 18, which is at present available in load capacities of 300 lb, 700 lb and 1 ton.

As can be seen in the drawing of a 700 lb capacity castor, the motion contact against a 1in diameter load ball causes it to rotate on a bed of $^{5}/_{32}$in diameter steel balls beneath it. These supporting balls are free to circulate over the lip of a concave-convex table mounted in the body of the unit. The balls are free to move to the underside of the convex surface and up over the opposite lip in any direction, and they thus provide an endless free-running track for the load ball.

The load ball is retained in the outer control race by a steel retaining washer and a felt seal



Construction of a 700 lb capacity universal ball castor

beneath this washer prevents the ingress of dust or dirt to the balls. The construction of the castor is such that it can be used in both the vertical and the horizontal planes. We are informed that this design of castor is to be made by the firm in a number of sizes for different capacities and applications.

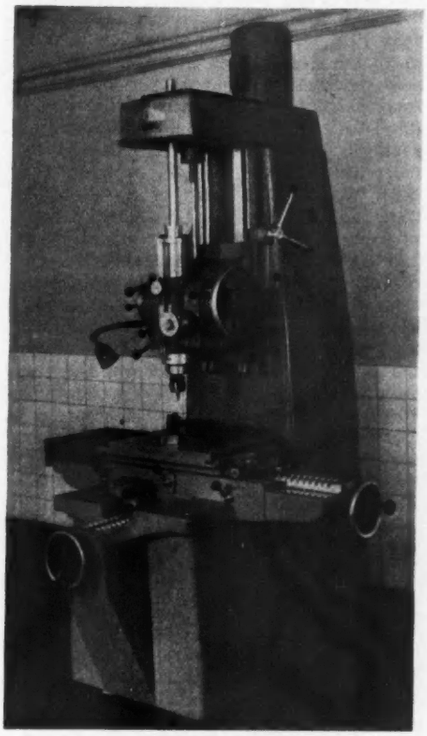
Stereoscopic Cinema Films

AT a meeting of the Scientific Film Association on May 29, Mr. T. J. Fletcher, of the Sir John Cass College, London, explained the methods of making three-dimensional moving pictures as applied to the mathematical films which were his interest. There was then shown a coloured film depicting the movements of the electric and magnetic lines of force when a cubical cavity resonated in each of the three modes H101, E111 and M111. The film used two separate pictures, each 8mm wide, on a 16mm film projected through a polarising attachment, and was viewed through "Polaroid" spectacles. At the conclusion of Mr. Fletcher's exposition, there was shown a new Shell film "Power in Perspective," taken by the Spottiswoode stereo camera and projected by a pair of 35mm instruments; this shows some highlights in the history of prime movers, illustrated by working models in the Science Museum.

Small Jig Borer

A NEW jig boring machine now being made by the Newall Engineering Company, Ltd., Old Fletton, Peterborough, is intended for use in small precision toolrooms or on light production work. The accompanying illustration shows the machine which is of generally similar construction to the larger ones made by the firm. Its 15in by 20in table has a 15½in longitudinal and a 10½in cross traverse, and the maximum distance between the spindle nose and the table is 20in, the spindle centre being 12in from the column ways.

The spindle of the machine is mounted on a precision taper roller bearing at the lower end and a double-purpose ball bearing at the top. It is mounted in a 3½in diameter quill and is driven by a three-speed a.c. motor through a four-speed gearbox, giving twelve speeds, ranging from 67 to 3000 r.p.m. Handwheels on the feed-



Small jig borer with twelve spindle speeds from 67 to 3000 r.p.m. and three power feeds

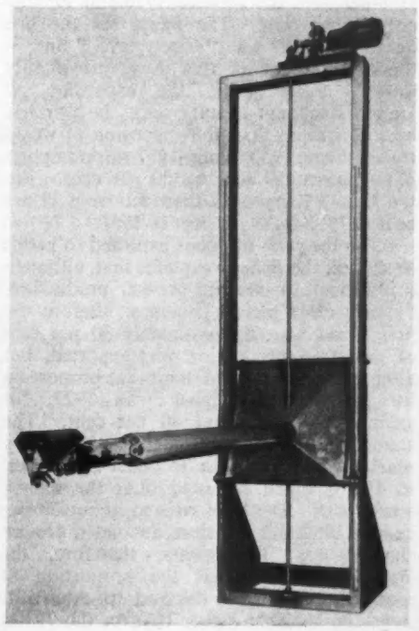
box give coarse and fine feeds and three up and down power feeds of 0·0015in, 0·003in and 0·006in per spindle revolution. A star wheel on the column operates through a rack and pinion to move the feed-box up and down the column. When this feed wheel is operated, it automatically clamps and unclamps the box on the column. The spindle nose has a No. 2 Morse taper bore.

The handwheel operated table is located by the Newall system of ground and lapped rollers which provide the main 1in gauging members. A "Microlocator," which is used in conjunction with the rollers for intermediate setting purposes, is divided into 0·0001in increments.

Welding Equipment for Cylindrical Vessels

AN automatic welding equipment, known as the high-lift internal welder, made by Quasi-Arc, Ltd., Bilston, Staffs, enables the welding of internal longitudinal seams in vessels from 30in up to 10ft in diameter and up to 10ft in length. The equipment can also be used for internal circumferential seam welding at diameters of 2ft 6in and over, as well as for external longitudinal and circumferential seam welding of vessels up to 10ft in diameter.

The equipment, as can be seen in our illustration, consists of an automatic welding head fixed at one end of a boom. This boom forms part of a fabricated steel assembly on the opposite end of which is fitted a support bracket incorporating four rollers. Through this bracket the boom is supported on a vertical fabricated frame. On this frame the boom assembly is raised and lowered by an a.c. motor driving a lead screw through bevel gears, an electromagnetic brake being provided to prevent over-run of the boom. Provision is made on the welding head for fine vertical and longitudinal adjustment of the welding nozzle in respect to the work. The hopper for the welding composition forms an integral part of the welding head, and the continuous wire electrode is fed to the head along the length of



Welder for the external or internal welding of vessels from 30in to 10ft diameter

the boom from a feed unit mounted at the rear of the supporting structure.

A guide wheel on the welding head which runs in the prepared gap in the work in front of the head in longitudinal seam welding ensures correct positioning of the nozzle in respect to the work. For internal circumferential seam welding on vessels of 2ft 6in diameter and over, the operator has access to the inside of the vessel to make any required adjustment to the welding nozzle.

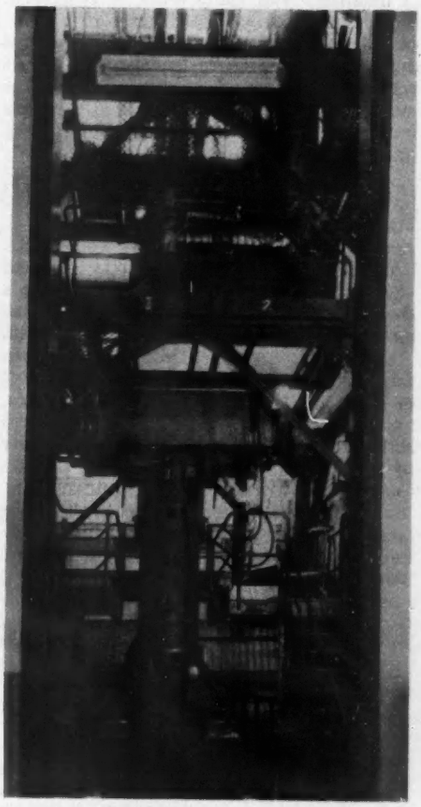
It is pointed out that for vessel welding the new equipment would normally be used in conjunction with a traversing roller bed for manipulating the vessel at controlled welding speeds.

Titanium Melting Plant

WHAT is stated to be the largest titanium melting furnace in Europe has been placed in operation at the Kynoch Works of I.C.I. Metals Division, Witton, Birmingham. This furnace is one of three supplied to the company by W. C. Heraeus G.m.b.H. (Western Germany), for the production of double-melted ingots up to 4200 lb in weight, by the consumable electrode arc melting process. The availability of such large ingots widens the scope of fabricating techniques which can be applied to titanium. In particular, it makes possible for the first time the rolling of slab into long-length coils by strip rolling techniques without the necessity for welding small coils together.

The high melting current employed in the new equipment facilitates more complete melting than hitherto and results in ingots of improved homogeneity and better surface quality. The furnace is illustrated herewith. It will normally operate with a high degree of vacuum, a pressure of under 10 microns being maintained throughout a melt, and facilities are also provided for melting under a reduced pressure of an inert gas, should this be required. Particularly useful are points in design which reduce "down time" between melts and effect big improvements in furnace utilisation. One such device enables the first-melt ingot to be withdrawn into the upper part of the furnace and held in vacuum while the larger-diameter crucible necessary for the second melt is fitted. Another device allows the second-melt crucible, containing the double-melted ingot, to be sealed by a plate valve and withdrawn from the furnace for cooling, so that the furnace can immediately be prepared for another melt.

The new installation incorporates advanced measures to ensure safe working. In it all operations are carried out by remote control and the furnaces are installed in massive reinforced concrete cubicles affording complete protection. In the control room, optical systems give operators a clear view of the furnace interior throughout the melting process, whilst instruments record



Electric arc furnace for melting titanium ingots up to 4200 lb in weight

essential technical data at all stages and incorporate a system of fault indication and location.

We are informed that it is less than three years since I.C.I. commissioned Britain's first titanium melting plant. Since then, technical knowledge has accumulated so rapidly that the company has twice replaced its entire complement of melting furnaces. It is, however, satisfied that furnace development has now achieved stability and that the present equipment will meet all foreseeable requirements for a much longer period. In 1955, eighteen furnaces were needed for an output of 1500 tons a year; to-day, three are sufficient to produce over 2000 tons a year.

SIGHT FLOW INDICATOR.—A new model of the sight flow indicators made by B. Rhodes and Son, Ltd., Queen Street, Romford, Essex, has the internal flap mounted slightly off-balance on the spindle. With this arrangement, when no flow is taking place in the line to which the indicator is fitted, the end of the flap points to the words "No Flow" on the cover. When a flow of liquid is passing through the indicator the flap end points to the word "Flow." This model of indicator can be adapted for up or down flow in vertical pipelines.

Industrial and Labour Notes

Wages and Hours

In his chairman's address to the annual congress of the National Union of General and Municipal Workers, last Monday, Mr. J. Cooper urged that the trade union movement should be willing " to look for modest, real wage increases instead of demanding substantial concessions," which, if realised, could only aggravate economic difficulties. Such a change in attitude, Mr. Cooper said, would at least provide a positive contribution that the Trades Union Congress could take to any government as a real gesture of co-operation in solving the problem of inflation. For many years, he remarked, the unions had obtained wage increases, only to see the temporary advantages gained disappear as a result of increased prices. It was surely better to have moderate wage increases under a stable level than excessive increases that were swallowed up by rising prices.

At another union conference this week, however—that of the National Union of Foundry Workers—the chairman, Mr. F. Hollingsworth, asserted that it would be a betrayal of trust not be press forward vigorously for a wage advance. The union's claim for a forty-hour week, he added, was long overdue and should be pressed with " all possible vigour." Mr. Hollingsworth said that, since the last pay increase, the cost of living had risen by 4 per cent. Moreover, many pay packets were smaller through short-time working and a shrinking capacity for bonus earning bringing a greater significance to the lowness of the standard rate. Mr. Hollingsworth went on to say that the restraint on the development of the nationalised industries had its effect on the demand from industries serving them. The continued pressure to reduce home demand by the Government's restraint on investment and its wage freeze policy, he commented, would further reduce production and create more unemployment.

Export Performance

The information division of the Treasury has published in its *Bulletin for Industry*, some comments on the country's export performance. It points out that there are a number of ways of measuring export performances, namely, by the volume of shipments, by the country's share in world trade in manufactured goods, and by the ratio of the country's exports to its total manufactures. But, the *Bulletin* says, the real test of the export drive lies in the condition of the balance of payments as a whole, and in particular it turns on whether the current surplus is adequate to meet all the United Kingdom's obligations as the central banker of the sterling area, a large overseas investor, and as a country with short and long-term obligations which must be discharged.

Since the war, the Treasury observes, there has been a high rate of increase in the volume of exports. Big changes in composition and in the relative price movements make comparison of the volume of exports over a long period somewhat imprecise, but it can be said that the pre-war volume of exports was about regained by 1946 and that since then it has doubled. This is in contrast to the period following the first world war ; in 1919 the level of exports was just over half the 1913 figure and the " pre-slump " peak in 1929 was still no more than 80 per cent of it. During the slump exports fell below the 1919 level, and it was not until 1950 that the 1913 figure for total exports was exceeded. Now, the *Bulletin* adds, there are signs that the steady growth of recent years has for the time being come to an end. Between 1955 and 1956 the volume of exports increased by 6 per cent, but between 1956 and 1957 by only 2 per cent. The figure for the last quarter of 1957 was " barely level " and in the first quarter of this year was slightly lower. Furthermore, the expansion of United Kingdom exports since the war has been less rapid than the expansion of world trade. From 1953 to mid-1957 world imports of manufactures rose by 50 per cent. But the United Kingdom's share fell from 21 per cent in 1953 to 18 per cent in 1957.

As to the ratio of goods exported to goods produced, the *Bulletin* explains that, although it is difficult to measure pre-war production, a fairly clear picture emerges. Before the first world war, approximately 30 per cent of industrial production was exported, but after that war, until the slump, the proportion was considerably higher ; in 1929, for example, it was about 40 per cent. The slump in the 'thirties brought about a very marked fall in the ratio (to under 25 per cent in 1935), which persisted until the second world war. The level rose to about 30 per cent in 1952 and has since fluctuated around that figure. It appears, therefore, the *Bulletin* remarks, that the proportion of manufacturing effort directed to exports is now considerably higher than in the 1930s, but is not by any means at an unprecedented level.

British Machine Tool Industry

A " note " which appears in the latest number of the Treasury's *Bulletin for Industry* says that the United Kingdom's machine tool industry is small in terms of the value of its output, which is equal to something like a half of 1 per cent of total industrial production. But it is, of course, a key industry providing machinery which is the basis of engineering production.

The output of the United Kingdom's machine tool industry last year was valued at £95,000,000, compared with £40,000,000 in 1950. Allowing for price changes, the Treasury says, this represented an increase in volume of about 50 per cent. The total industrial staff employed on machine tool production grew, in the seven years, by 22 per cent, so that there was a rise in output per head of something like 25 per cent. In the metal, engineering and vehicles industries as a whole, output rose in the same period by 30 per cent, with a rise in employment of 15 per cent, which indicates a gain in output per head about half that in the manufacture of machine tools. The *Bulletin* adds that machine tool production in Germany, as in the United Kingdom, has grown consistently, though the expansion has been more rapid since 1955. German deliveries in 1957 were 32 per cent higher than in 1955 ; the equivalent United Kingdom figure was 27 per cent. At the same time the United States machine tool industry has shown itself capable of meeting large and sudden increases in demand and has therefore shown considerable fluctuations in output and employment. Its post-war peak in 1953 was an output valued at 1200 million dollars, four times greater than its 1950 figure ; but last year its output fell to 849 million dollars.

Industrial Disputes

The Ministry of Labour has recently completed a detailed survey into stoppages of work arising in 1957 from industrial disputes in the United Kingdom. During last year there were 2871 stoppages brought to the Ministry's notice, which involved directly and indirectly approximately 1,359,000 workers. The aggregate number of working days lost by these stoppages was 8,412,000, the highest number in any year since 1926. The number of workers involved in all the stoppages in progress during last year represented about 5½ per cent of the total in civil employment and the loss of time for each of the workers involved averaged about seven working days during the year. But, the Ministry explains, as in other recent years, most of the stoppages were of short duration. Less than 7 per cent of them lasted more than six working days, and in the majority of stoppages the numbers of workers involved and the aggregate loss of time were relatively small. The outstanding exceptions last year, and those that accounted for the large total of working days lost, were the stoppages in the engineering and shipbuilding industries in pursuit of a claim for a 10 per cent wage increase. The stoppage in the engineering industry involved about 615,000 workers in various parts of the country and resulted in an aggregate loss of about 4,000,000 working days. In the shipbuilding and ship repairing industries approximately 2,150,000 days were lost by the 165,000 workers who were involved.

Inflation

Speaking, on Thursday of last week, at the annual meeting of British Timken, Ltd., the chairman, Sir John Pascoe, said it was becoming increasingly clear that this country was unable to isolate itself from the recession in the U.S.A. That recession might well deepen during the coming months and we should only be able to hail a revival when the laid-up ships sailed from our estuaries and when the prices of primary products started to rise.

Sir John went on to say that, in its battle to preserve the standard of living of the people of this country, which was the correct way of looking at what was known as the battle against inflation, the Government had " just concluded an indecisive engagement with one section of industry." There was now perhaps a greater realisation in the country that any increase in wages unaccompanied by an increase in output per man-hour would definitely be inflationary. It must be remembered, however, that any increase in productivity over the whole country could only be a matter of a small percentage per annum, possibly under 5 per cent. Nevertheless, Sir John commented, a rate of 3½ per cent would easily enable us to double our output and so our standard of living well within the suggested twenty-five years. A point to be borne in mind, if inflation was to be avoided, was that it was questionable whether a given percentage increase in productivity would justify an equal percentage rise in wages as there were other factors to be taken into consideration.

West German Brown Coal

No. I

A substantial proportion of the German Federal Republic's electricity, and large amounts of domestic and industrial fuel, are derived from lignites, the largest deposits of which are found in the Rhineland west of Cologne. The present article reviews the development of this coalfield which, since the war, has undergone an unprecedented expansion. Since we published our article on this subject ten years ago, deep opencast mining, the feasibility of which was then still under debate, has made rapid strides through the introduction of extra-heavy machinery.*

BESIDES deposits of hard coal, the most important of which are in the Ruhr district, with smaller ones near Aachen and in the Saar, Germany possesses important deposits of brown coal, estimated at 105,000 million tons, of which about 40,000 million tons are in East Germany and in the district now under Polish administration. These deposits are of particular importance to East Germany because of the lack of hard coal, of which only 2,500,000 tons per year are being mined. On the other hand, the output of brown coal has been nearly doubled since 1946, and last year amounted to 214 million tons. In view of the large-scale dismantling of mining plant which took place after the war, and which was one of the principal causes for the drop in output in the immediate post-war period (Table I), the subsequent development must be

TABLE I—*Production of Brown Coal in East Germany*
(Millions of Tons)

Year	Brown coal	Briquettes	Coke
1936	101	23·5	—
1945	85	—	—
1946	108	29·0	3·5
1947	102	26·8	3·2
1948	110	29·8	—
1950	137	37·7	5·2
1951	151	41·1	5·7
1953	173	45·7	6·2
1956	206	—	—
1957	—	—	—

regarded as an important achievement. Before turning to the West German lignites which form the main subject of this article, we shall briefly review the position in the German Democratic Republic, which gives an interesting background for comparison.

Brown Coal in East Germany

Most of the East German brown coal is mined in three regions, those of Borna (including the districts of Zeitz, Altenburg and Meuselwitz), Halle (including Aschersleben, Magdeburg, Bitterfeld, Oberöblingen and Geiseltal), and Lausitz (Upper and Lower Lausitz and Hirschfelde). The coal is used, in the form of briquettes, for domestic heating and on the railways. Large amounts are burned domestically as crude brown coal. In this form the coal is, however, mainly used for the production of electricity.

According to present estimates, the lignite reserves are composed of 36 per cent briquetting coal, 27 per cent boiler coal (large ash content), 16 per cent coking coal (low sulphur), 15 per cent gas coal (tar content 10 per cent or more), and 6 per cent coal with a high salt content.

Experiments for the production of metallurgical coke from brown coal go back to the years before the war. By 1960, coke production is to be expanded from about 6,400,000 to 8,000,000 tons, of which at least 2,500,000 tons would be hard coke. The first cokery for hard coke was begun at Lauchhammer in 1951 and is now being followed by the " Schwarze Pumpe " plant near Spremberg.

Coal with a large tar content is gasified, the low-temperature coke being burnt in power stations. The hydro-carbons produced are further processed into motor fuels, for which they are the country's principal source (Leuna-Werke), and synthetic rubber (Buna-Werk Schkopau).

West German Brown Coal

Turning now to the mining of lignite in the German Federal Republic, we find that for domestic and industrial uses, brown coal plays a subsidiary part because of the wealth of hard coal which is available. However, it is becoming increasingly difficult to get the hard coal because of the beginning of exhaustion of the top seams and the consequent necessity of working at levels of 1200m below ground and less, where the great heat seriously hinders operations. It is for this reason that the demand for brown coal is increasing. When dried and briquetted, large quantities are consumed domestically, but in view of the large water and ash content of the coal, it is more profitable to fire it in power stations situated in the vicinity of the mines.

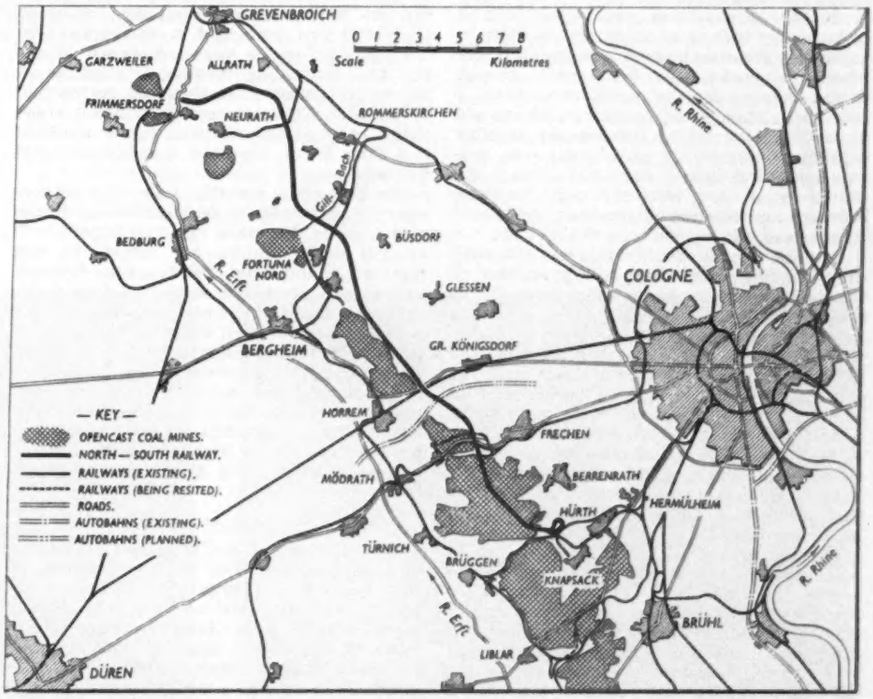
The chief deposits occur on the left of the Rhine in a region which extends from near Bonn and Cologne to Aachen, in the west, and to the Dutch border in the north (see map). Smaller fields are found in Hesse and Bavaria. An extension of the Magdeburg field at Helmstedt is also on Federal territory. In recent years the Rhenish lignite field produced over 86 per cent of the total West German output and nearly 90 per cent of total output of briquettes. Table II gives figures for 1956 and (preliminary) for 1957.

The remarkable increase in production which has taken place will be realised when the output in the past is compared with the present. At the turn of the century, about 40,000,000 tons of lignite were produced per annum in the whole of Germany, of which 9,250,000 tons were made into briquettes. By 1920, these figures had risen to 111 million and 24,000,000 tons, respectively, and by 1943 to 255 million and 61,000,000 tons.

In the year 1938, the Rhineland district produced 57,600,000 tons of brown coal (including the coal for 10,500,000 tons of briquettes). Table III shows the development after the war.

TABLE III—*Output of the Cologne Lignite Field*
(Millions of Tons)

Year	Output	Briquette manufacture
1936	48·7	10·5
1938	57·6	12·0
1945	16·6	3·7
1946	43·3	9·8
1947	49·1	10·6
1948	54·5	11·6
1950	63·7	13·4
1952	71·4	14·9
1954	75·7	15·0
1956	82·1	15·2



The principal brown coal field of the German Federal Republic, extending west of Cologne from near Bonn to the Dutch border

The deposits occur on the left of the Rhine in a region which extends from near Bonn and Cologne to Aachen, in the west, and to the Dutch border in the north (see map). Smaller fields are found in Hesse and Bavaria. An extension of the Magdeburg field at Helmstedt is also on Federal territory. In recent years the Rhenish lignite field produced over 86 per cent of the total West German output and nearly 90 per cent of total output of briquettes. Table II

TABLE II—*West German Output of Brown Coal*
(Millions of Tons)

District	1956			1957		
	Crude coal	Briquettes	Working days	Crude coal	Briquettes	Working days
Rhineland ...	82·1	15·2	303	83·4	15·1	301
Helmstedt ...	6·7	1·5	305	6·6	1·5	303
Hesse ...	6·4	0·2	304	6·8	0·2	302
Bavaria ...	—	—	302	—	—	301
Total	95·2	16·9	—	96·8	16·8	—

In view of the rapidly rising demand, it became necessary to begin mining the deeper seams in the northern part of the coalfield (see map). At first it was thought that the usual underground coal-mining procedure might be successfully adopted and a 350m deep twin-shaft mine was constructed by the Rheinische Braunkohlentiefbaugesellschaft m.b.H., an association of several mining companies formed in 1938. However, it became clear after some years that the required rate of expansion could not be achieved, if shafts had to be sunk, as these take a matter of years to construct. Production costs would also be heavier than was supportable in view of the low calorific value of the coal.

This appraisal of the situation was borne out by later developments. While the output of hard coal increased by 22 per cent between 1950 and 1956, that of the deep brown coal mines increased by only 12 per cent. Most of this increase took place in the Hessian mines near Kassel, which accounted for 90 per cent of the 2,400,000 tons deep brown coal produced in the German Federal Republic in 1956.

The deep-mining of brown coal is rendered

* " Opencast Mining in the Rhine Brown Coalfield," by W. L. G. Muir, THE ENGINEER, April 9, 1948, page 344 ; April 16, page 368, and April 23, page 392.

difficult by the plastic or friable nature of the tertiary clays and sands in which the seams are bedded and which make it impossible to keep open large spaces. The presence of sand and clay usually prevents the use of much of the machinery for coal-getting and handling which is used in hard coal mines. Most of the coal-getting is done by hand, and experiments with electrically- or compressed-air-driven coal cutters have not yet met with success. About 30 per cent of the coal is won during the advancing of the galleries. The coal is removed in 700 to 800 litre tubs of 600mm gauge, which allow transport by hand on gradients up to 4 deg. In the main galleries the tubs are pulled along by chains, a system which dates from before the first world war. More recently the use of belt conveyors has come to the fore. Much difficulty is caused by the large amounts of water which are encountered.

The fact that underground mining is labour-intensive while opencast mining is machine-intensive is a strong factor against deep mining, particularly with the present shortage of skilled miners.

Owing to the impossibility of expanding the deep mining of brown coal, it was therefore decided to proceed by the method of deep opencast mining, depths of 250m and more being considered feasible. One precondition was the unified planning of operations over a large area, partly because individual mines would have to be larger for reasons of safety and in order to utilise fully the extra large excavating equipment which is required ; partly because only through overall planning can the complex operations of excavating, piling of the overburden, mining and backfilling be carried out economically, together with the movement of populations, the construction and shifting of roads and railways, the restitution of land after the coal has been extracted, and the siting and construction of power stations and high-tension transmission lines.

As a first step, the whole region was systematically investigated by taking a large number of sample drillings. As in the other lignite fields, the coal occurs as an upper seam which is on average about 20m thick, and some 50m underneath it a lower seam with a thickness of 60m to 100m. The depth below the surface varies considerably and fluctuates owing to the presence of faults. Outcropping coal in the south of the district has long since been exhausted and most of the near-surface mines there are also either worked out or will be within a few years.

Towards the north, as has been mentioned, the coal seams drop down to depths of 200m to 300m and below.

This means that the ratio of overburden to coal, which in 1954 was 0·6 : 1, is expected to increase to about 2·5 : 1 in the course of the next few years. This is still much more favourable than the conditions in East Germany, where the overburden : coal ratio is of the order of 4 : 1 to 6 : 1, and occasionally reaches 10 : 1. As our map shows, the present coalfield is situated mainly on the hills west of Cologne, known as the Vorgebirge or Ville (from the Roman villas situated there when Colonia was a Roman garrison town), and the slopes towards the valley of the River Erft, which flows at first in a north-westerly direction, roughly parallel with the Rhine and then curves eastward to flow into the Rhine south of Düsseldorf. If an east-westerly section is considered, it is found that between Frechen and Horrem the coal is approximately 40m below the surface, subsequently dropping to 145m in the Horrem fault. A major disturbance of the strata occurs along the course of the Erft valley, west of which the coal seams are found to have descended to a depth of 540m below ground level, rising again gradually to a more favourable level around Weisweiler.

This situation of the strata accounts for the fact that the large-scale mining of the coal first started seventy-five years ago in the south and is now progressing towards the north-west, with additional mines being opened up around Weisweiler. In this process, the number of mines is being decreased, and the size of the individual units increased. While at present there are still nineteen opencast mines in operation, producing 82,000,000 tons per annum, their number will have decreased by 1962 to twelve, but producing together 100,000 tons per annum. Whereas in 1952 established mines produced 91 per cent of the total output and new mines only 9 per cent, this year new mines will account for over half the output, and by 1962 they will provide over 80 per cent of the coal.

The movement of mining activity is characterised by an increase, not only in the ratio of overburden to coal, but also in the quantities of water which have to be pumped out. Until 1952, while the ratio overburden : coal increased from 0·3 : 1 in the early days to about 0·8 : 1, the water : coal ratio remained roughly constant at 1 : 1. From then until 1962, a sharp increase will take place. Two years ago, for every ton of coal, 7 cubic metres of water had to be pumped out, and this year it will be 9 cubic metres, while the overburden : coal ratio has risen to 1·8 : 1. In 1962, the amount of water to be pumped will be 10 cubic metres for every ton of coal. The overburden ratio which will then be 2·3 : 1, will continue to increase gradually to over 2·8 : 1 in the 1970s, but the amount of water to be pumped is expected to decrease again to a figure of about 2 cubic metres per ton of coal.

In 1956, the German Federal Republic produced some 95,000,000 tons of crude brown coal, 82,100,000 tons in the Rhineland. Of the total output, over 34,000,000 tons were burnt in thermal power stations and 8,000,000 tons for other heating and industrial purposes, while the remainder was made into briquettes, of which 16,300,000 tons were sold in that year. The tonnage difference is largely explained by the fact that briquetting involves a reduction in the water content from about 60 per cent to 15 per cent. This, incidentally, brings it about that over long distances the savings in transport cost alone are an important factor in favour of briquettes.

The briquetting industry is therefore of considerable importance in the West German brown coal economy, but while the more recently built electric power stations are within the new northern mining area, the briquette factories, which mostly date back over many decades, are situated in that southern part of the region which is rapidly being worked out. In order to avoid having to shift these establishments, and to move and resettle their workers, it was decided to provide a special railway system to feed both the power stations and the briquetting plants. This line, which is electrified, is constructed with heavy rails to support high axle loads. From its general direction, it is known as the North-South Railway.

Electricity Production

While the production of briquettes for domestic and industrial uses, which in 1955 was 44,000,000 tons, is intended to remain roughly the same for the next few years, and brown coal for " other users " will fall from 8,000,000 tons in 1955 to 5,000,000 tons in 1962, lignite production for use in public supply electric power stations is scheduled to undergo a steady increase. Within the seven-year period 1955–62, this sector is to be expanded from 25,000,000 tons to 52,000,000 tons per annum. The installed capacity is to be increased from 2630MW in 1955 to about 4000MW in 1960, and 4700MW in 1965.

The use of brown coal as a fuel in thermal power stations dates back to the last years before the first world war, when it became possible to transmit electric energy over long distances. Lignites have a low calorific value, chiefly owing to the high ash and water content—the Rhenish brown coal, with 60–62 per cent water, has a calorific value of 1600–2000kcal per kilogramme, the Hessian with 48 per cent water, 2000–2900kcal per kilogramme. Such fuels cannot economically be transported over long distance and it was necessary to bring the power stations to the fuel, instead of the other way round. Demands for cheap electricity during 1914–18 for the chemical and metallurgical industries caused the construction of over a dozen thermal power stations. In the Cologne coalfield may be mentioned the expansion of the Goldenberg-Werk in connection with a nitrogen plant at Knapsack, and the construction of the power stations, Fortuna, Frimmersdorf, and Zukunft. Before the second world war in 1937, nearly half the total German electricity was produced from brown coal, nearly one-third from hard coal, and the remainder from water power. In 1949, owing to the effect of the war, lignites accounted for only 24·6 per cent, hard coal for 50·4 per cent, and water power and other sources of energy for 25 per cent of the electricity produced, the proportion generated from brown coal increasing to 31·5 per cent by 1956. Owing to the cheapness of the brown coal, this trend may be expected to continue.

Thermal power stations operating on brown coal supply the basic load, their utilisation amounting to some 6000 hours per year. If an average specific consumption of 2 kg crude coal per kilowatt-hour is assumed—modern turbo-sets operating on the block system reach 2500–2800kcals per kilowatt-hour—the amount of fuel which it is envisaged will be available in 1960—42,000,000 tons of raw coal—would be enough to produce 23,000 million kWh. This is the expected output of the condensing power stations and to it must be added another 1500 million kWh from the back-pressure turbines of the briquetting factories.

Some 90 per cent of the planned expansion will be in the Rhenish coalfield. Thus, the Goldenberg-Werk (R.W.E.) is to be expanded to 1000MW, while Fortuna (R.A.G.) will even exceed this figure. The first stage of the R.W.E. power station Weisweiler has been completed, comprising two block sets of 100MW each and one of 150MW. The Weisweiler power station of B.I.A.G. has been expanded to 240MW. To the old 88MW power station at Frimmersdorf (R.W.E.), a modern 200MW plant has been added. In Bavaria, Hesse and Lower Saxony (Helmstedt) expansions and new constructions amounting to over 450MW have been carried out since the war.

(To be continued)

Nuclear Research in French Aviation

In 1956, S.N.E.C.M.A. created an Atomic Department for studying the application of nuclear energy to the operation of gas turbines. This department was naturally created with a view to future aeronautical applications, though the technical and scientific work in which it is engaged is of a much more general character. At present, the facilities include a research section for atomic piles, a research section for thermal studies, a calculation department, a research and development section for aerodynamic studies, a production workshop and test installations.

Some of the work is carried out in co-operation with the Commissariat à l'Energie Atomique and in the framework of an association which in addition to S.N.E.C.M.A., also includes the Hispano-Suiza and Turbomeca companies.

German Road Accident Rate

In 1957, the steadily mounting accident rate in the Federal Republic not only came to a halt for the first time since the end of the war but even receded. As compared to 1956, the number of persons killed in road accidents declined by 3·9 per cent, while the relevant figure for injured persons dropped by 2·2 per cent. According to the Federal Office of Statistics in Wiesbaden, 12,386 persons were killed in 1957 through accidents and 353,063 persons injured.

This fortunate reduction in the accident rate is largely accredited to the enforced speed limits which went into effect on September 1, 1957.

Heating for Road Surfaces

On the orders of the Federal Ministry of Transport, Bonn, an autobahn bridge near Montabaur (Westerwald) has been equipped with electric heating in order to obviate the dangers from ice. The arrangement, which is stated to have been very successful so far, comprises heating elements which are situated immediately underneath the steel mesh reinforcement of the road surface. It is intended to apply this system in the first instance to mountain roads, stretches with steep gradient, and in particular to autobahn bridges. Other possibilities are aerodrome runways.

Continuous Casting of Large Tough Pitch Copper Slabs

BY OUR AMERICAN EDITOR

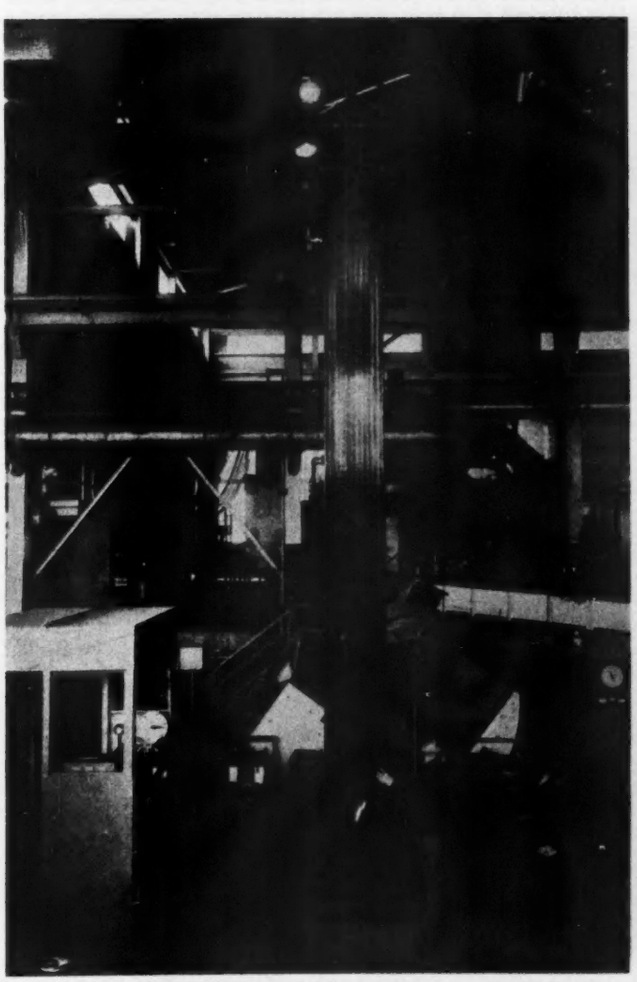
THE first commercial unit in the United States for the continuous casting of tough pitch copper slabs from which copper sheet and strip are rolled has been installed by the American Smelting and Refining Company at its Perth Amboy, New Jersey, refinery. The process employed permits casting of copper cakes up to 25ft long by 3ft wide and weighing over 17,000 lb. The capacity of the new slab casting installation is about 160 tons of copper per eight-hour shift. Particularly significant is the size of the copper slabs which are now being produced by the new casting procedure. With the longer lengths now available to them, copper rolling mills will be able to roll more tonnage per hour, with a consequent gain in plant efficiency and reduction in operating costs. Moreover, the metal cast by the new method is unusually sound and dense and has a surface uniformity which is ideal for rolling.

The so-called "Asarco" casting technique, as illustrated here, is unorthodox. It eliminates batch casting in costly individual metal moulds by the use of a small, "bottomless" water-cooled graphite mould. Molten copper is poured continuously into the mould cavity, is cooled so rapidly that it solidifies as it passes through the mould and emerges from the orifice as a smooth, dense copper slab. The mould is the key element of the process. It is only 15in deep, but it has been designed so that it has a heat dissipation rate of about 64,000 B.Th.U. per minute. This is believed to be the highest heat dissipation capacity per square inch of surface of any mould ever built for either ferrous or non-ferrous casting. The design enables the mould to solidify molten copper cast at 2100 deg. Fah., as it traverses the 15in mould depth at a speed of up to 20in per minute in the case of a 5in by 36in slab. This is equivalent to casting 1150 lb of copper per minute.

The mould design eliminates the need for mould preparation compounds as used in conventional water-cooled copper moulds. To prevent sticking of the cast copper to the mould, and to ensure a smooth slab surface, the entire mould assembly is oscillated by a reciprocating gear. The vertical stroke is only a fraction of an inch and the variable speed driving motor can operate up to several hundred cycles per minute. At the present time, the "Asarco" technique is being used to continuously cast tough pitch copper—the kind of copper which represents about 90 per cent of U.S. consumption. However, the process can be used, with minor modifications, to produce slabs of oxygen-free, phosphorised or other special coppers.

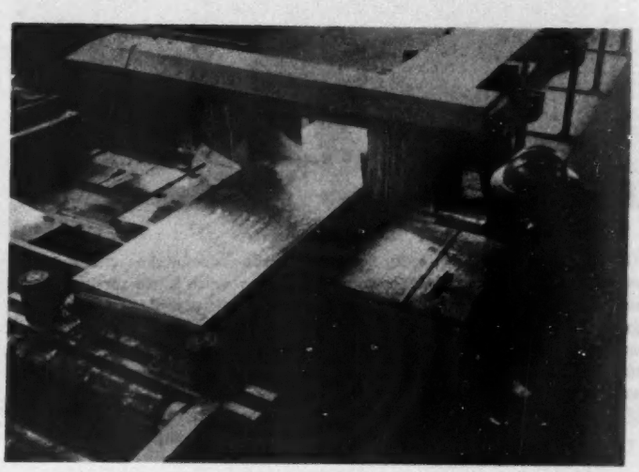
The conventional method of manufacturing tough pitch copper slabs has been to cast them in individual, water-cooled copper moulds. The kind of mould customarily used yields a "cake" 25in to 36in wide, 4½in to 7in thick and 36in to 92in long. One of the limitations imposed on the size of slabs of optimum quality that can be turned out by old methods is that they must be vertically cast. Horizontal casting was not practicable because the quality of the slab surface, which is of paramount importance to rollers, was impaired. A short slab, even of top quality, is far from ideal for many modern rolling mills. In recent years, many of these mills, confronted by higher labour costs, have installed larger and faster rolling equipment. But they have not been able to utilise these modern facilities at maximum efficiency and most economically, with the slab sizes available. Longer slabs were the real need of most mills, since they permit the production of the maximum quantity of sheet and strip per hour with a minimum number of passes through the rolls. The "Asarco" development has solved this basic problem of the industry. Continuously cast slabs, up to 25ft long, in the thin dimensions desired, can now be made in widths of 25in, 30in and 36in.

At the Perth Amboy installation, the mould is situated at ground level at the mouth of a specially constructed, 61ft deep, water-filled well. As the solid cake emerges from the bottom of the mould it is cooled by a series of high-speed water-spray jets. It then is lowered continuously into the reservoir of cooling water. The cooling water is circulated by a pump having a capacity of 1800 gallons per minute. As one precautionary measure, a duplicate pump is installed in the system which will cut-in automatically if the operating pump should fail. In addition, an emergency pump operating from an independent power source will take over in case of primary power failure. The slab is lowered into the well by a stainless steel hydraulic ram which has



5-ton slab of tough pitch copper produced on continuous casting installation shown, with mould assembly at lower right

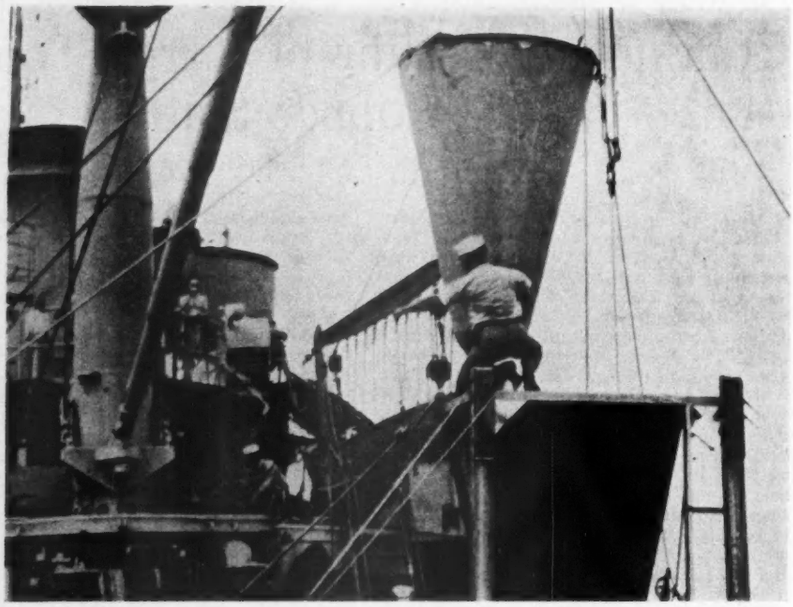
Flow of molten copper from the holding furnace through a special pouring ladle and casting funnel into the casting mould

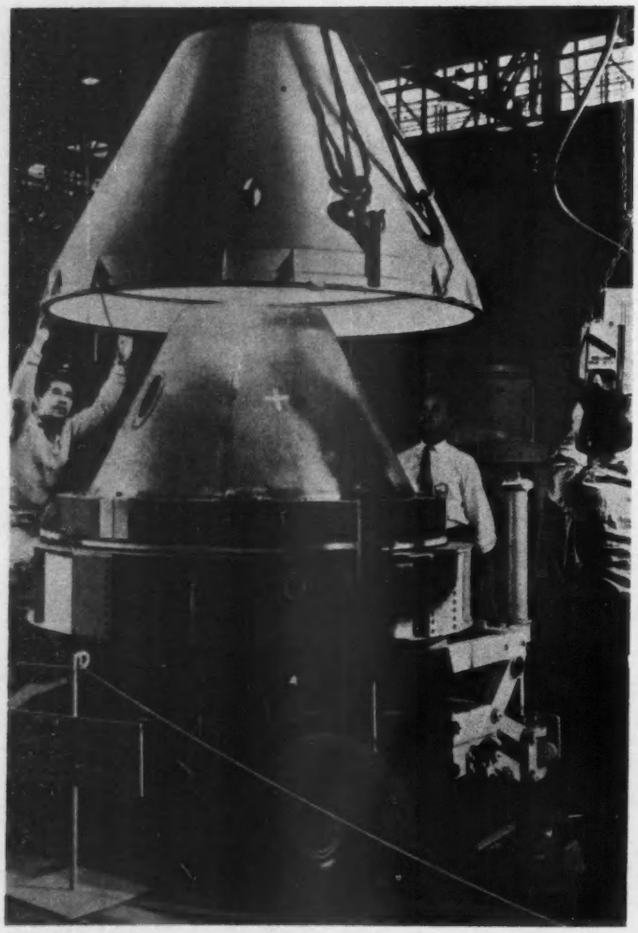


Subdividing of continuously cast copper slabs on high-speed circular saw cutting at a feed of 48in per minute

Re-Entry Bodies

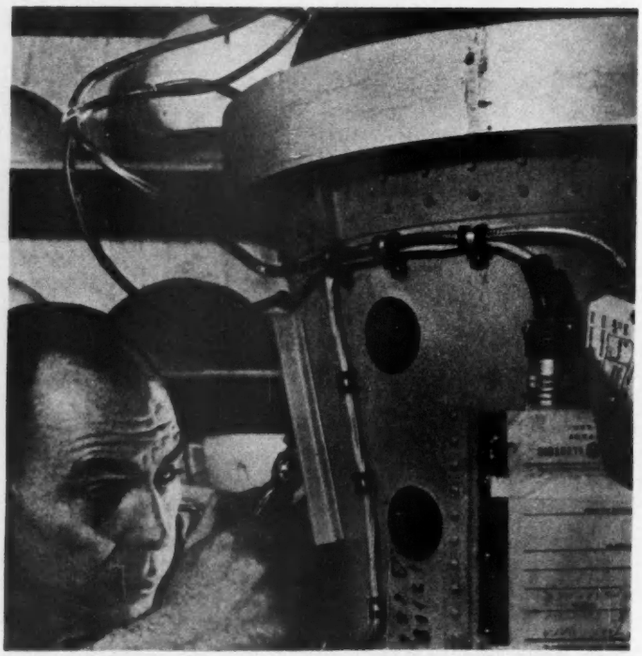
Some of the most ambitious attempts to extend the state of the art are to-day taking place in connection with the re-entry problem, the task of bringing a payload down, from orbital or near-orbital velocity in the upper regions of the atmosphere, to the earth's surface. The kinetic energy to be dissipated is ample to vaporise the body, and aerodynamics must be invoked to divert part of it to the atmosphere. This fundamental approach, of increasing the wave drag relative to the viscous drag, has the disadvantage, as far as a missile is concerned, of reducing the terminal velocity, thus increasing the errors due to wind and easing the task of detecting and destroying the store. Thus, the warhead of the United States Army Ballistic Missile Agency "Jupiter" i.r.b.m. is relatively streamlined in shape and fabricated from an outer shell of reinforced plastics which is allowed to decompose at its surface, the heat transfer inwards being slow enough for the interior structure and warhead to be undamaged. A test cone is seen, RIGHT, being recovered after being fired a full 1500 miles over the sea.





The development of the re-entry body is not made easier by the fact that information is needed about the behaviour of examples which fail to survive, while telemetry is often corrupted or prevented by the ionisation of the surrounding gases. A data recovery capsule has therefore been evolved which contains automatic recording gear and is ejected before the nose cone reaches the ground : the high-drag configuration suffers maximum deceleration and heat input rather early in its descent. Notice the apparently heavy and conventional construction of the capsule in the PICTURE, RIGHT : the war-head of an actual weapon has a weight in the order of tons (mega-ton yield)

Of particular interest in Great Britain is the re-entry body developed by The General Electric Company for the Convair "Atlas" i.c.b.m. and Douglas "Thor" i.c.b.m. of the United States Air Force, since the same nose cone will, it is expected, be used on the De Havilland missile : the British firm is already licensed to build the General Electric "T-58" variable-stator shaft-power gas turbine. The very blunt nose of this re-entry body is already familiar (page 286, February 21, last), but the PICTURE, LEFT, shows the after-body : the nose cone is stowed head downward in its carrier case on a wheeled trolley. The lifting loops on the lower part of the case show that the blunt front remains in the case until it has been mated with the nose of the vehicle which, on the "Atlas," has a distinctive corrugated surface. This body is, of course, of the relatively low speed class and protects the payload by acting as a heat sink : while such materials as beryllium have been investigated, General Electric uses copper, the high conductivity of which gives a great resistance to thermal shock, while a commercially available metal is obviously attractive for a weapon, the "Thor," needed in quantities in the near future. It is necessary to align the nose with its direction of motion before it enters the atmosphere, and to do this control jets are placed in the rear part



a 27ft stroke. The rate of lowering is constant, regardless of the varying weight on the ram. The ram, and its actuating hydraulic equipment, is completely submerged in water. The withdrawal rate, rate of casting of metal, coolant flow, and other vital elements of the casting shop, are electronically controlled. One operator can govern the entire casting operation from the electronic control centre situated in a booth a few yards from the casting pit. After the slab is cast, the mould is swung to one side and the 25ft long slab is lifted by a 10-ton crane to a nearby platform. There it is sawed to the precise lengths which are specified by the rolling mills. The saw is of unusual capacity and cuts through the slab at a speed of 4ft per minute. As it is now installed, the casting shop includes two moulds, side by side. The new unit is capable of casting two cakes, at a rate of up to 20in each per minute, simultaneously.

The slab casting unit is actually the second phase of the firm's expansion and modernisation of its Perth Amboy casting shop. Earlier this year, the company installed what is claimed to be the world's largest direct-arc copper melting furnace there ; by June it will also have completed the construction of new and larger facilities for the continuous casting of copper billets. All three operations—continuous copper melting, slab casting and billet casting—will be integrated operations. The melting furnace will provide the molten copper for slabs, billets and, in addition, for the company's new Perth Amboy wire bar casting wheel. The new furnace has a bath capacity of 90 tons of molten copper and is designed to melt copper cathodes at a rate of 30 tons per hour. Currently, the 8000kVA furnace is operating substantially in excess of rated melting capacity. For the slab casting unit, tough pitch copper flows down a launder from the arc furnace to a 10-ton holding furnace. The metal temperature is adjusted in the holding furnace to 2100 deg. Fah. This metal flows through a special pouring ladle to the distributor, which ensures a smooth, splash-free entry of metal into the mould cavity.

The copper furnace employs three 18in diameter graphite electrodes, each of which, when assembled, weighs 4000 lb. Their positions, which determine the arc length, are controlled hydraulically. Particularly significant is the installation of this furnace in an area of high power cost (about 1 cent per kilowatt-hour) and reasonable fuel cost. This indicates that even under such unfavourable conditions, arc furnace installations can be designed to be competitive with the fuel-oil-fired reverberatory furnaces conventionally used throughout the industry. For equal yearly production, the capital cost of a large arc furnace and auxiliaries is less than that of multiple reverberatory installations and their auxiliaries. Moreover, the furnace turns out a smooth and continuous flow of uniformly high-quality copper of low sulphur content which can be cast at convenient rates. By contrast, a large reverberatory furnace requires that 300 to 400 tons of copper be cast in no more than five hours.

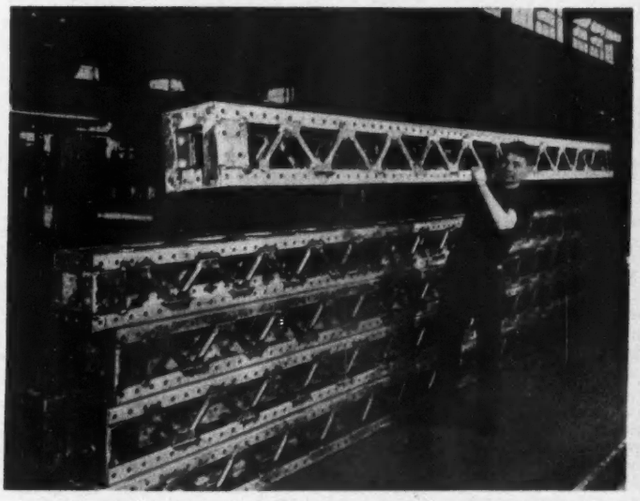
At Perth Amboy, the company has for the first time combined an oil-fired preheating furnace with the electric arc furnace to use both sources of heat at optimum efficiency. Copper in the form of cathode sheets is heated to 1500–1600 deg. Fah. in a rotary preheating furnace. In addition to heating the copper with relatively inexpensive oil, this step permits a low-sulphur feed to the arc furnace. The heated, low-sulphur cathodes are then transferred to the arc furnace, where the copper is melted and heated to 2100–2150 deg. Fah. The molten metal is cast at 2030 deg. Fah., flowing continuously by displacement and by adjustment of the furnace tilt angle. The operation of an arc furnace to melt copper poses special problems to furnace designers and operators. The arc discharges from the bottom of the electrodes to the molten bath, and requires the accurate maintenance of an air gap of ¼in to 1in at all times. Ripples due to charging or surges in the bath require an extremely sensitive control system to permit the electrodes to adjust automatically to the constantly changing conditions at the metal surface. If the electrodes are lowered too far, a short circuit results ; if withdrawn excessively, the arc is snuffed. Obtaining the necessary sensitivity of control in combination with rapid motion of the massive electrodes and their holders was a formidable requirement. It was accomplished by utilising a rotary regulator and controls actuating hydraulic servo system which was designed to the firm's specifications by the Whiting Corporation and the General Electric Company.

Tests on the operating furnace show that electrode motion starts within one-twelfth second after receipt of the control signal. Despite the need to handle 10 tons of electrodes and holders, full reversal of the electrodes can be accomplished in one-third of a second when the electrodes are travelling at a rate of 10ft per minute. The electrodes are, of course, consumed continuously and at periodic intervals the power is shut off for electrode addition. A new section of electrode is screwed on to the top of the existing section. Except for these additions, and infrequent periods for slagging, door cleaning or adjustment, the furnace can be operated continuously.

Prefabricated Aluminium Trusses for Electricity Substations

An interesting concept in aluminium substations, which is expected to achieve substantial savings in design, field assembly time and maintenance, was demonstrated recently with the assembly of a unit made of prefabricated aluminium. Based on the use of standard prefabricated aluminium components, the new substation erection method, known as "Alrectic," was developed by the Handley-Brown Company of Jackson, Michigan, with design and engineering assistance from the Kaiser Aluminum and Chemical Corporation. The first installation was a 46kV substation for the Consumers Power Company. Less than a day was required to assemble the components for this substation. The "Alrectic" method takes full advantage of the high strength, low weight ratio and ease of workability of aluminium. By reducing design, transport and field assembly costs, the new system is competitive with conventional galvanised steel construction and offers the further advantages of attractive appearance and corrosion resistance, which eliminates the need for painting and other costly maintenance.

The new system utilises standard truss beams, together with fixtures and other parts. The trusses are 1ft square or 1ft by 2ft 6in and are available in lengths up to 60ft. They are of welded construction and consist of four extruded aluminium chords supported by lacing. The sides and ends are precision punched with holes spaced at 3in intervals. Field assembly is quick and easy. The trusses are simply bolted together to form columns and horizontal members. Most members can be raised into position by one or two men, as shown in the accompanying illustration. A 10ft "Alrectic" truss of the 1ft square size, for example, weighs only 94 lb as compared with some 290 lb for an equivalent steel component. A 16ft aluminium section weighs only 145 lb compared with 443 lb in steel construction. The use of aluminium extrusions permits the use of single trusses up to 60ft in length, or approximately three times the maximum length of conventional galvanised steel members, which are limited by the dimensions of the galvanising equipment.



Manual handling of 16ft aluminium truss section weighing 145 lb for electricity substation construction

Private Sales of Uranium to Foreign and Domestic Buyers

The U.S. Atomic Energy Commission has announced that domestic producers of uranium ores and concentrates may now make private sales of these materials to domestic and foreign buyers for peaceful uses of atomic energy. As in the case of other forms of uranium materials, such as refined salts and metal, all sales will be subject to licensing by the Commission. As a result of this action by the Commission, United States industry will be able to compete with other countries for the growing foreign and domestic market for nuclear fuel. The Commission believes that the eighteen uranium mills now in operation and those being built or planned will produce sufficient concentrates to meet the needs of the Commission for the next several years and also to take care of the commercial demands as American industry establishes new outlets.

The Commission will consider the release of uranium under contract to the A.E.C. These releases will be subject to such contract modifications as may be deemed appropriate. U.S. companies wishing to sell or purchase uranium materials at home and those desiring to sell such uranium materials to firms in friendly foreign countries must first obtain licences from the Division of Licensing and Regulation, U.S. Atomic Energy Commission, Washington 25, D.C. Upon receipt of satisfactory information concerning the proposed use of the materials abroad, the Commission will issue licences authorising the export of uranium for amounts required by countries having comprehensive agreements for co-operation, which provide suitable assurances against diversion to military use, or with whom the United States has made other suitable agreements. Such agreements are now in effect with twelve countries planning nuclear power programmes. These countries are : Australia, Belgium, Canada, Federal Republic of Germany, France, Italy, Netherlands, Norway, Spain, Switzerland, Union of South Africa and the United Kingdom.

The existence of such governmental agreements is not necessary, however, with respect to the issuance of export licences authorising cumulative shipments of up to 100 kg of contained normal uranium to a single foreign consignee, providing that no one country receives from the United States more than 1000 kg under these circumstances. This licensing policy will enable foreign users to continue to purchase from U.S. sources those small quantities of uranium materials required in basic research and medical and general industrial applications even though government-to-government agreements do not exist. Such sales, however, will require licences to be issued before shipment can be made. The sale of special nuclear materials (U-233, U-235 and plutonium) remains on a government-to-government basis and cannot be made directly to private users in the United States or abroad.

Personal and Business

Business Announcements

MR. H. W. BOYNE has joined the staff of Colloidal Graphite, Ltd., 6 and 7, St. Dunstan's Lane, London, E.C.3.

FERODO, Ltd., has announced that Mr. L. Clements, export manager, has retired after thirty-nine years' service with the company.

MR. JOHN MCLAREN, A.C.G.I., A.M.I.C.E., consulting engineer, has moved from No. 13 to No. 28, Victoria Street, London, S.W.1 (telephone Tate Gallery 0774).

CHEMICAL CONSTRUCTION (GREAT BRITAIN), Ltd., states that in July it is to move to new premises at Henrietta House, Henrietta Place, London, W.1 (telephone Langham 6571).

MR. R. E. BURNETT, general manager, and Mr. S. G. SPOONER, production manager, of Marconi Instruments, Ltd., have left this country for a three-weeks' marketing tour of the U.S.A.

GEORGE KENT, Ltd., announces that it is establishing a branch office in the Ruhr. The address of the office is Zweigniederlassung für Deutschland, Krefeld-Westparkstrasse, 54 (telephone 25692).

ARMSTRONG SIDDELEY MOTORS, Ltd., Coventry, states that in order to facilitate production and internal management within its organisation, it has taken over Armstrong Siddeley (Brockworth), Ltd.

ARMOUR CHEMICAL INDUSTRIES, Ltd., 4, Chiswell Street, London, E.C.1, states that it has taken over business of the chemical division and the Armour Laboratories, hitherto part of Armour and Co., Ltd.

MR. D. J. W. BOAG, managing director of Rockweld, Ltd., has left England by sea for North America. Mr. Boag is visiting the company's Canadian subsidiary, Canadian Rockweld, Ltd., and his tour will include visits to New York, Philadelphia and Toronto.

A. F. CRAIG AND CO., Ltd., Caledonia Engineering Works, Paisley, Scotland, and HUDSON ENGINEERING CORPORATION, Fairview Station, Houston, Texas, U.S.A., have signed an agreement establishing A. F. Craig and Co., Ltd., as sole manufacturer under licence in the United Kingdom of Hudson air cooled heat exchangers.

THE GOODYEAR TYRE AND RUBBER COMPANY (GREAT BRITAIN), Ltd., announces the formation of a new division, to be known as the engineering products division, which will take over the further development, manufacture and testing of Goodyear industrial disc brakes and Goodyear "Ausco" double-disc brakes.

Appointments

MR. P. B. WARD has been appointed sales manager of Technical Designs, Ltd.

MR. A. J. C. FAGG has been appointed home sales manager of Merton Engineering Company, Ltd.

MR. E. S. H. JANES has been elected president of the Incorporated Advertising Managers' Association.

MR. DAVID GRAY has been appointed secretary of the Industrial Welfare Society with effect from July 1.

MR. J. HAMMOND has been appointed deputy chief engineer of Samuel Fox and Co., Ltd., Stocksbridge.

MR. S. R. B. BREWER, A.M.I.E.E., has been appointed a director of Bryce Electric Construction Company, Ltd.

SIR ARCHIBALD F. FORBES, chairman of the Iron and Steel Board, has been appointed a director of Dunlop Rubber Company, Ltd.

THE GLACIER METAL COMPANY, Ltd., has announced that Mr. F. B. McPherson has been appointed deputy managing director.

MR. MICHAEL F. KELLY has been appointed sales manager, tractors, of Mackay Industrial Equipment, Ltd., in succession to Mr. A. J. C. Fagg.

MR. G. S. MCDONALD, M.I.C.E., M.I.Mun.E., has been elected president of the Institution of Structural Engineers for the session 1958–59.

THE BRITISH TRANSPORT COMMISSION has announced that Mr. John Bowman and Sir George Walton have been appointed members of its North Eastern Area Board.

MR. J. FLOWETH has been appointed Nottingham branch manager of British Insulated Callender's Cables, Ltd., following the retirement of Mr. M. H. Healey.

THE MERSEY DOCKS AND HARBOUR BOARD has appointed Mr. N. A. Matheson, M.I.C.E., M.I.Mech.E., to be its principal assistant engineer-in-chief.

MR. B. L. SCOTT, A.M.I.E.E., has been appointed manager of the Newcastle upon Tyne area branch office of George Ellison, Ltd., in succession to Mr. J. Gibbins.

MR. J. E. CLARK has been appointed manager of the Midlands district for British Oxygen Gases, Ltd., in succession to Mr. J. G. Williams who has retired after forty-six years' service with the company.

FERRANTI, Ltd., has announced that Mr. K. Ripley has been appointed to succeed Mr. Frank Hope as chief test engineer, transformer department. Mr. Hope has retired after forty-six years' service with the company.

DR. R. H. DODD has been appointed managing director of Chemical Construction (Great Britain), Ltd., in succession to Mr. M. S. Henderson, who has retired. Mr. Henderson remains a director of the company.

THE MINISTER OF POWER has appointed Sir Henry Spurrier, chairman and managing director of Leyland Motors, Ltd., and Mr. A. E. Pearce, director of Qualcast, Ltd., as part-time members of the Iron and Steel Board.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., has announced the appointment of Dr. L. W. Brown, M.I.E.E., as assistant chief electrical engineer (light current), in addition to his present duties as chief engineer, electronics department.

BABCOCK AND WILCOX, Ltd., announces that Mr. P. H. Dunn has been appointed assistant sales manager at the company's head office in London. He has been succeeded as representative of the company in New York by Mr. T. S. Blackadder.

MR. J. W. BENNETT has been appointed general manager of the Canadian British Aluminium Company, Ltd., in succession to Mr. P. T. Ensor who is returning to the United Kingdom in July to take up other duties with the British Aluminium Company, Ltd.

THE MINISTRY OF TRANSPORT AND CIVIL AVIATION has announced that the appointment of Mr. D. J. Swift as deputy chief road engineer, Scotland, announced on May 15, has been cancelled at his own wish, and that Mr. H. N. Ginns, A.M.I.C.E., has been appointed to the post.

Contracts

THE BRITISH TRANSPORT COMMISSION announces that an order has been placed with the Ailsa Shipbuilding Company, Ltd., for a double-ended passenger and vehicle ferry for the Lymington–Yarmouth service operated by the British Railways Southern Region. The ship will have an overall length of 164ft by 30ft moulded breadth and have a deadweight capacity of 90 tons. There will be accommodation for 620 passengers and 26 motor vehicles and propulsion will be by two Voith-Schneider propellers, each driven by a Crossley diesel engine of 320 b.h.p. at 600 r.p.m., to give a speed of 10½ knots.

THE BRITISH TRANSPORT COMMISSION announces that an order is being placed with the English Electric Company, Ltd., for twenty-two main line, 3300 h.p. "Deltic" type diesel-electric locomotives for use on express passenger services between London (King's Cross), Leeds, Newcastle and Edinburgh. The existing "Deltic" locomotive, described in our issue of November 4, 1955, has been on trial in regular service on British Railways since November, 1955. Deliveries will begin in 1960, and it is expected that by mid-1961 the diesel-electric locomotives ordered will be in service in replacement of fifty-five main line steam locomotives. The new locomotives will each be powered by two 1650 h.p. Napier "Deltic" engines; they will have a C-C wheel arrangement and will be classified as type "5."

Miscellanea

PNEUMATIC SELECTOR VALVE.—A ten-port pneumatic selector valve which is now being made by Martonair, Ltd., Parkshot, Richmond, Surrey, is designed for simplifying the sequence control in process operations. With this valve compressed air can be supplied from each of the ten outlets in turn for the operation of pneumatic cylinders or relay valves.

COUPLINGS FOR SMALL NYLON TUBES.—To meet the demand for couplings for fractional outside diameter nylon tubes, Compression Joints, Ltd., Tyburn Road, Birmingham, 24, has developed the "Nitex" tube nut design compression fitting. With this design of fitting the tube is not damaged and no special tools are required with its use. The fittings are also suitable for copper tubes and are available in a range of sizes for tubes from ¼in to ¾in outside diameter.

FILING CABINET FOR DRAWINGS.—A new filing cabinet for drawings and tracings made by Lawes Rabjohns, Ltd., Abbey House, Victoria Street, London, S.W.1, has been designed to give quick and easy insertion, location and removal of any drawing or tracing, without damage. A vertical system of filing is used, and one cabinet will hold about 2400 40in by 27in drawings, or a greater number if the sizes are assorted.

ERRATUM IN "METALLURGICAL TOPICS."—In "Metallurgical Topics," on page 808, of our issue of May 30, an error appeared at the bottom of the third column. Under "Sprayed Metal and Plastics Coatings," the third sentence should have read: "Zinc protects ferrous surfaces by preferential (or sacrificial) corrosion; aluminium protects ferrous surfaces by sealing off the surface with a tenacious oxide film from the corrosive environment."

SIX-WHEELED GOODS VEHICLE.—A six-wheeled commercial chassis for no more than 15 tons gross is now available in the form of the Commer-Uniformer 10-ton chassis. This is a variant of the 7-ton 13ft 6in Commer with a second axle added at the rear, using components of the existing vehicle wherever possible. The additional axle is not driven, and advantage is taken of the considerable margin between the gross weight and the legal maximum to place more weight on the centre than the rear axle. The revised wheelbase is 15ft 7in and the turning circle 71ft. The vehicle is powered by the three-cylinder opposed-piston oil engine, driving through a four-speed synchromesh box with two power take-off facings: a two-speed axle or a fifth gear may be specified as extras.

TESTING SAFETY GLASS.—Among the standard tests used on "Triplex" safety glass is one in which the "modulus of rupture" (flexural stress at rupture) is measured. The test specification (A.S.T.M. C.158) lays down that the stress in the specimen must be uniformly increased by 10,000±1000 lb per square inch per minute without vibration. We understand that the hydraulic equipment used for this purpose was designed and made by Keelavite Rotary Pumps and Motors, Ltd. in conjunction with the "Triplex" laboratory. The test piece is cut to 10in by 1½in, according to the A.S.T.M. rules, and supported on two stainless steel knife edges 8in apart. A third knife edge is brought down by a hydraulic cylinder to load the glass at the middle. Load and deflection are measured.

PLASTICS TOOLING.—There has now been prepared by Shell Chemical Company, Ltd., Marlborough House, 15/17, Great Marlborough Street, London, W.1, a booklet describing the applications and method of use of "Epikote" resins in tooling applications. The epoxy compounds are suggested as having the most attractive mechanical and physical properties of the various resins available: two grades are available, 815 being more easily poured and 828 having a higher resistance to heat. The properties can be further modified by the choice of fillers: polyamide or polysulphide compounds are available which increase the flexibility and impact resistance of the finished product. Of particular interest, is that "Aerosil" can be used to obtain a thixotropic mix for use as a tool facing, on vertical surfaces, or as a cement. The guidance on manufacture of tools is particularly complete, and includes a list of the suppliers of release agents, polishes, reinforcements, and wax sheet of specified thickness that may be needed.

ELECTRICAL DEVELOPMENT.—Speaking at the annual luncheon of the Electrical Development Association (E.D.A.) in London, recently, Sir Christopher Hinton, chairman of the Central Electricity Generating Board, commented on some aspects of the load factor of electricity supplies. Because the policy in this country was to supply electricity at all times with only small price differentials, the load factor was 46 per cent, which was lower than in many other countries. Therefore, to meet the peak loads, old and inefficient stations had to be retained because the cost of replacing them could not be justified since they were only on load for a relatively short time per day. The cost of electricity from the fifty lowest-merit stations in Great Britain last year was 1s. 9d. per unit. Hence it was very important that consumers should be encouraged to adopt equipment with a good load factor. Lord Chandos, the retiring president of E.D.A., who replied to the toast of "Electrical Development," advocated the removal of purchase tax from all domestic electrical appliances, since it was illogical to applaud labour-saving devices only so long as they applied to the factory and office and not in the home. Turning to the future, Lord Chandos forecast that the harnessing of thermo-nuclear power would take place more quickly than scientists were prepared to predict publicly.

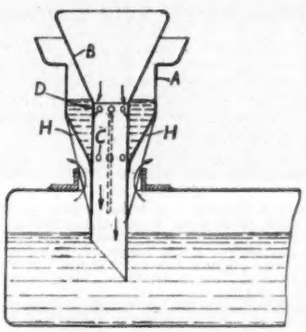
British Patent Specifications

When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification. Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each.

FILLING FUEL TANKS

794,927. October 28, 1955.—FILLING DEVICES, Delta Motor Research, Ltd., Potton Manor, Potton, Bedfordshire. (*Inventor: Otto Anton V. Smekal.*

The invention relates particularly to filling devices used to fill a vessel with two miscible liquids. It is of particular value in connection with the filling of the fuel tank of a vehicle with a mixture of oil and



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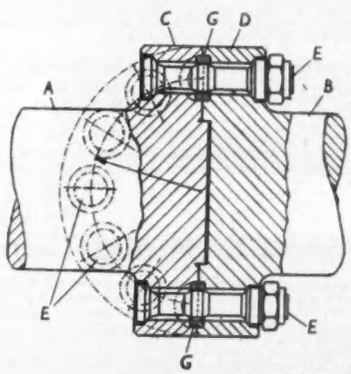
petrol. The device shown in the drawing consists of an outer funnel *A* and an inner funnel *B*, the funnels being sealed together. The inner funnel is provided with lower apertures *C* and upper apertures *D*. The device is shown in position with the lower extremity of the funnel *B* passing through a filling aperture of a tank. The device is provided with three fins *H* which serve to provide passages for air to escape from the tank. The apertures *D* have co-operating inwardly-directed baffles as shown. In use, petrol is introduced into the funnel *B* from a petrol pump and oil is introduced into funnel *A*. A first mixing takes place at apertures *D* by movement of petrol in the direction shown by the arrows and a second mixing takes place at apertures *C*, so that a thorough mixture reaches the lower part of the funnel.—*May* 14, 1958.

POWER TRANSMISSION

794,956. November 21, 1956.—SHAFT COUPLINGS, Brown Boveri and Co., Ltd., Baden, Switzerland.

The invention relates to shaft couplings for coupling together a pair of rotor shafts of machines, particularly those where large powers have to be transmitted, such as in the case of steam and gas



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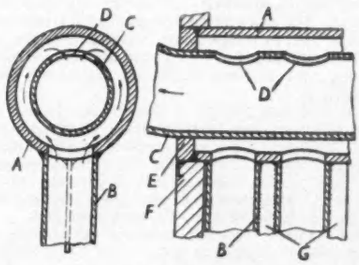
turbines. A coupling according to the invention is constructed as a flange coupling, the coupling halves being held together by bolts, and has shear rings one of which is placed coaxially around each bolt, and lies between the flange halves. As shown in the drawing both shafts *A* and *B* have at their ends half coupling flanges *C* and *D* respectively. The coupling bolts *E* arranged uniformly on the bolt circle have a diameter smaller than that of the holes in the flange halves. Around each coupling bolt and coaxial with it there is a shear ring *G* between the flange halves. The shear rings lie in suitable short bores in the flange halves in such a manner that the end surfaces of the coupling flanges can be pressed together with the desired pressure. The coupling bolts are pre-stressed sufficiently for the transmission of the axial force, the bending moment and approximately the normal power of the machine. The shear rings then transmit any torque peaks which may occur. The coupling bolts have a clearance in their bores and in the shear rings.

With the coupling described it is possible to transmit a considerably larger power with a certain external coupling diameter than with the usual flange couplings of the same diameter. The coupling bolts even when subjected to torque peaks have only to withstand their prestressing and are not subjected to any shear stress. Since they are fitted into the bores with clearance, they can easily be inserted and removed, especially as they are not deformed by excessive stressing and cannot become stuck due to rust. The shear rings take over the function of the contact bolts which are usually employed. When the coupling has to be dismantled it is only necessary to pull each shear ring out of its short bore to the extent of half its axial length, whereby any damage to the coupling bolts is avoided.—*May* 14, 1958.

STEAM GENERATORS

794,828. April 1, 1955.—STEAM GENERATORS AND HOT-WATER BOILERS, Heinrich Vorkauf, Weinheimer Strasse 3, Berlin-Schmargendorf, Germany.

The invention relates to heated tube walls in steam generators or hot-water boilers which are so disposed in the combustion gas flow that they are heated from both sides. They are frequently used as closed tube walls for guide or baffle walls in the combustion



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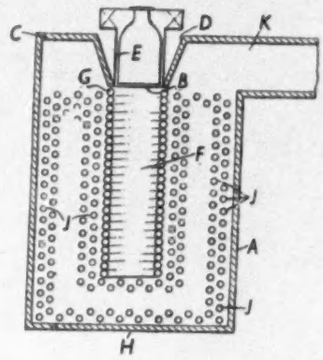
chamber or as tube panels lying parallel to one another and freely crossing the combustion chamber, as additional radiant heating surfaces. In the drawing is shown a collector *A*, around which combustion gases flow and into which the evaporator tubes *B* of a tube wall discharge from below. In the collector is a central insert tube *C* which, on the side remote from the tubes *B*, has a number of apertures *D*. Instead of the apertures, the tube *C* may also have a continuous slot. The mixture emerging from the evaporator tubes *B* flows round and then enters the insert tube *C* through the apertures. From the insert tube the mixture is led off to a steam separator. As shown in the right-hand view, the insert tube *C* is passed through the bottom plate *E* of the collector *A* and the collector is mounted in the walls *F* of the gas flue. The intermediate spaces between the tubes *B* can be sealed in the case of a closed guide wall by welded-in sheets *G*. A modified design is also shown in the specification.—*May* 14, 1958.

794,894. April 12, 1954.—FORCED CIRCULATION WATER TUBE BOILERS, John Thompson Water Tube Boilers, Ltd., Ettingshall Engineering Works, Wolverhampton. (*Inventor: Gilbert Ashton Plummer.*)

The invention relates to forced circulation water tube steam generators to be fired by an intimate mixture of liquid or gaseous fuel and air and to a method of firing such generators. Its object is to provide an improved steam generator which does not necessitate a large combustion chamber so that the overall size, cost and weight of the generator can be reduced. Referring to the drawing the boiler comprises a hollow outer casing *A* of circular cross-section having a central aperture *B* in its upper end *C* within a recessed portion *D* and a combustion chamber *E* located immediately above the aperture *C*. A cylindrical chamber or gas cooling space *F* is bounded by a helical coil *G* of water tubes and extends down from the aperture *C* to terminate at a position short of the base *H* of the casing. Successive turns of the coil *G* are in contact. The coil within the casing is surrounded by an annular space which has a series of steam generating tubes *J* coiled in known fashion. The tubes are also located in a space beneath the helical coil. A gas outlet or flue *K* towards the upper end of the casing extends radially outwards. The external combustion chamber *E* is provided with burners which may be of known type so that substantially complete combustion of the fuel used takes place in the external combustion chamber and non-luminous high temperature gases pass down



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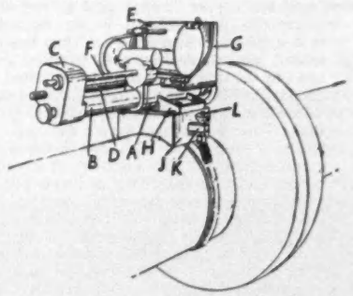
through the gas cooling space *F*. The gases then pass up between the coiled steam generating tubes *J*, and are withdrawn from the boiler through the gas outlet or flue *K*. The use of an external combustion chamber as described enables the volume of the cylindrical chamber or gas cooling space *F* to be considerably reduced from that which would be required if combustion occurred within the gas cooling space.—*May* 14, 1958.

WORKSHOP TOOLS AND APPLIANCES

794,826. February 19, 1955.—PORTABLE BORING MACHINES, Buma Engineering Company, Ltd., and Austin Patrick Malia, both of the Engineering Works, Robson Street, Newcastle upon Tyne. (*Inventor: Austin Patrick Malia.*)

This invention relates to portable boring machines. One object of the invention is to provide a portable boring machine which is light enough to be carried by one man and which in addition to providing for vertical boring can be mounted on a workpiece for boring in a direction parallel to the longitudinal axis so as to obtain very accurate mating of holes in neighbouring flanges one of which is on the workpiece. Another object is to provide means in ship repairing whereby the boring of bolt holes in propellor shaft flanges, may be carried out *in situ* without the necessity of dismantling the propeller shaft. Referring to the drawing the machine base comprises a cylindrical portion *A* which is adapted to receive the slidable boring bar casing *B* in which is mounted the rotatable boring bar fed by a suitable feed gear. The feed gear is housed in a box *C* and rotates a nut on a feed screw *D*. The drive is by an electric motor *E* through a grooved driving spindle *F*. Integral with the lower portion of the cylindrical base portion *A* is a right angle bracket *G* or "normal bracket," while along the side of the cylindrical portion *A* of the base is a relatively wide plate or bracket *H* or "parallel bracket" arranged symmetrically about the longitudinal plane containing the axis of the boring machine and the centre line of the normal bracket. The brackets *G* and *H* constitute the supporting means for the machine which can be mounted on either of their two faces. The face of the bracket *H* has a detachable packing block shaped to mate snugly



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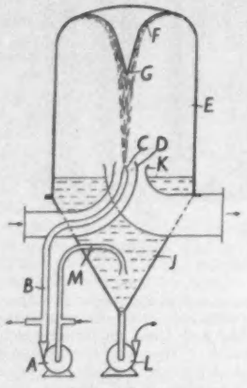
with the shaft or other workpiece on which the machine is to be mounted. The drawing shows an application of the machine for boring holes in the flanges of a ship's propeller shaft. Mounted on the face of the parallel bracket *H* is a packing block *J* having on opposite sides bored lugs *K* for receiving adjusting studs *L* to which are connected the ends of a chain adapted to pass around the propeller shaft *M*.—*May* 14, 1958.

GAS CLEANING

794,060. October 28, 1955.—METHOD OF AND APPARATUS FOR SCRUBBING GASES, Farbenfabriken Bayer Aktiengesellschaft, Leverkusen-Bayerwerk, Germany.

The invention provides a method of scrubbing gases with liquid, which comprises directing a jet of liquid upwardly from a substantially central position in the lower portion of a substantially vertical scrubbing tower having a closed upper portion,



No. 794,060

directing a jet of gas upwardly concentrically surrounding and in contact with the jet of liquid, deflecting the jets of liquid and gas at the upper portion of the tower to reverse the flow of the jets and cause the liquid to flow down the wall of the tower, and removing the gas from the tower separately from the liquid through a gas outlet surrounding the initial part of the jet of gas. As shown in the drawing, a pump *A* feeds the scrubbing liquid through a pipe *B* to a nozzle *C*, from which it issues in a free jet. The jet of ascending liquid spreads out and splits up into separate droplets. The jet of scrubbing liquid is surrounded and penetrated by a jet of the gases to be scrubbed. These gases also enter at the lower end of the scrubbing chamber through a supply pipe *D* surrounding the liquid supply pipe. The jet of mixture, consisting of liquid and gas, ascends in the scrubbing chamber *E* and is deflected by 180 deg. surfaces *F*, at the upper end of the chamber, which preferably merge into a central downwardly directed point *G*. The maximum scrubbing effect is thus obtained. The liquid and gas then flow down the walls of the tower. The liquid collects in the sump *J*, while the scrubbed gases are discharged through an outlet pipe *K*. Any solids in the sump can, if desired, be removed by means of a sludge pump *L*. The pump *A* also extracts liquid from the sump through intake pipe *M*.—*April* 30, 1958.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

DOMED METALLIC BURSTING DISCS AND BURSTING DISC ASSEMBLIES

No. 2915 : 1957. Price 6s. The first section of this new standard specifies requirements for the metal foil of which bursting discs are made. Ten preferred metals are listed—ranging from aluminium, austenitic stainless steel and copper through gold to iron alloy. Test requirements are specified in an Appendix, and there is a full-page diagram of a "test holder." In the second section, dealing with bursting discs, a table sets out the number of discs to be tested out of batches ranging in quantity from three to eight discs at one end of the scale and from 1001 to 10,000 at the other. Full test instructions are specified.

Subsequent sections deal with disc holders and with vacuum supports. The adoption of a coding system is specified with the object of preventing the inadvertent fitting of an incorrect bursting disc. Other items dealt with include the marking of holders, packaging and identification of bursting discs, and the identification of vacuum supports. It is pointed out that this standard should be read in conjunction with the appropriate clauses of B.S. 1500 (Provisional) "Fusion-Welded Pressure Vessels for Use in the Chemical and Allied Industries" (particularly those clauses relating to the relieving capacity of safety devices).

STIFFNUTS (UNIFIED THREADS) FOR AIRCRAFT

Nos. 2A.125-2A.168, 2A.180, 2A.181, 2A.186, 2A.187, 2A.192, 2A.193, 2A.200 and 2A.201 : 1958. Price 12s. 6d. These "aircraft" series British Standards have been revised to introduce requirements for sizes of nuts with threads below ¼in UNF. An important feature of the publication is a reclassification of the nuts according to the operating temperatures for which they are suitable, as follows:—−75 deg. to +425 deg. Cent., corrosion-resisting steel nuts, silver-plated; −75 deg. to +200 deg. Cent., steel and corrosion-resisting steel nuts, cadmium-plated; −75 deg. to +125 deg. Cent., aluminium alloy, brass or bronze nuts.

As in the first edition of the standards, provision is made for hexagon nuts, anchor nuts and stripnuts. The standard contains nineteen tables, and each is shown in conjunction with fully annotated line drawings.

STEEL ROLLER CHAINS AND CHAIN WHEELS FOR AGRICULTURAL AND SIMILAR MACHINERY

No. 2947 : 1958. Price 5s. The chains specified in this publication can be geared with wheels made for the malleable iron detachable link chains specified in American Standard A.S.A.—B.29.7—1954. It deals with a range of steel roller chains allied to the long pitch chains given in B.S. 288, "Steel Roller Chains and Chain Wheels." It specifies requirements for: dimensions, tolerances, non-destructive proof loads to which the product must be subjected, destructive minimum breaking loads for samples, and marking. Other requirements relate to chain attachment plates and to chain wheels.

DIESEL ENGINES FOR GENERAL PURPOSES

No. 649 : 1958. Price 5s. The extensive developments which have taken place during recent years in diesel engine manufacture, and the greatly increased use of diesel power in industry, have made necessary a revision of the specification for diesel engines for general purposes, which was last revised soon after the war. The new edition now published is narrower in scope than its predecessors, because there are now separate standards for rail traction diesels and tractor engines, and it concentrates on stationary diesel engines.

An important change in the revision is that the basis of rating has been simplified; the previous twelve-hour rating has been replaced by a continuous rating. Derating formulæ for altitude and temperature have been extended to include pressure-charged engines. Two classes of governing are now specified and the test requirements have been amplified.

The standard includes guidance on engines for diesel-electric generating sets. Limits are specified for cyclic irregularity and, in the case of alternator sets which may be parallel with others, for angular deviation. Appended to the standard are catalogues of information which should be supplied by the purchaser when making an inquiry or ordering, and by the manufacturer when tendering. Another appendix gives a rapid method of estimating the site rating of an engine to provide a given electrical output from a generating set.

VOLTAGES FOR A.C. TRANSMISSION AND DISTRIBUTION SYSTEMS

No. 77 : 1958. Price 3s. This further revision of the old-established B.S. 77 has been published mainly because of the changes in the organisation of the electricity supply industry in the United Kingdom since the last edition appeared; the scope of the standard has been extended to cover industrial systems as well as public supply systems. The new edition is in close agreement with Publication 38 of the International Electrotechnical Commission, particularly as regards the upper voltage limit associated with each system voltage, upon which the design of much electrical equipment depends. Only 415/240V is now recognised as standard for three-phase, four-wire distribution systems. The number of standard voltages above 1000V has been reduced, but 330kV and 380kV have been added to the list. Preferred voltages for new installations are clearly indicated.

MEASUREMENT OF SMOKE EMISSION FROM INDUSTRIAL BOILERS

B.S.I. COMMITTEE'S FIRST REPORT ON CONTROL OF INDUSTRIAL SMOKE

No. 2978 : Part I. Price 5s. The first report has now been published of the work of the B.S.I. Committee which has been investigating the extent to which smoke from industrial boilers can be reduced by good practice. The report, covering medium capacity coal-fired water-tube boilers with travelling grates is published as Part I of this new British Standard. The next part of this standard to be issued will be concerned with shell boilers fired by various kinds of mechanical stokers. The report which has just been published is expected to be of value to factory management and to local authorities in helping them to achieve a good standard of smoke control and compliance with the law under the terms of the Clean Air Act.

To obtain the material on which this report is based the B.S.I. Committee carried out tests on four water-tube boilers of modern design, known to be well operated, at a brewery, a paper mill, a chemical works and a colliery. Detailed records were kept of smoke emission from each of these plants over periods of from five to nine weeks. A résumé of results for each of the four boilers is given in the form of a table. There are notes on frequency of soot blowing; on smoke emission during overload, rapidly changing load, when lighting up and bringing up to load, and during mechanical breakdowns. The final conclusion is that "from the figures collected in this report, it would appear that average emissions of dark smoke in excess of six minutes per shift per boiler can normally be avoided in water-tube boilers with travelling-grate stokers within the size range 30,000 lb per hour to 50,000 lb per hour." A helpful section at the end of the report lists factors influencing smokeless combustion on travelling-grate stokers.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME and PLACE at which the meeting is to be held should be clearly stated.

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

To-day, June 6.—BRISTOL AND WEST OF ENGLAND BRANCH: Grand Hotel, Broad Street, Bristol, Annual General Meeting, 7.45 p.m. ★ LIVERPOOL AND DISTRICT BRANCH: Liverpool Engineering Society, 9, The Temple, 24, Dale Street, Liverpool, 2, Annual General Meeting, 6.30 p.m. ★ STOKE AND CREWE BRANCH: Grand Hotel, Hanley, Stoke, Annual General Meeting, 7.30 p.m.

Mon., June 9.—CENTRAL LONDON BRANCH: White Hall Hotel, Bloomsbury Square, London, W.C.1, Annual General Meeting, 6.30 p.m. ★ NORTH WEST LONDON BRANCH: Century Hotel, Forty Avenue, Wembley Park, Annual General Meeting, 7.30 p.m.

Tues., June 10.—PORTSMOUTH BRANCH: Wiltshire Lamb Hotel, Portsmouth, Annual General Meeting, 7.30 p.m. ★ YORK BRANCH: "Georgian House," Blossom Street, York, Annual General Meeting, 7.30 p.m.

Wed., June 11.—BIRMINGHAM BRANCH: Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham 2, Annual General Meeting, 6.30 p.m. ★ BRADFORD BRANCH: Midland Hotel, Bradford, Annual General Meeting, 7 p.m. ★ HALIFAX BRANCH: Crown Hotel, Horton Street, Halifax, Annual General Meeting, 7.15 p.m. ★ LUTON BRANCH: Luton and Dunstable Chamber of Commerce, George Street West, Luton, "Slot Insulation from the Inside (Class 'E')," R. A. Joseph, 8 p.m.

Thurs., June 12.—SOUTH WEST LONDON BRANCH: "Prince of Wales" Hotel, Wimbledon, S.W.19, Annual General Meeting, 7.15 p.m.

COMBUSTION ENGINEERING ASSOCIATION

Wed., June 11.—Grand Hotel, Charing Cross, Glasgow, C.3, "A Survey of Boiler Cleaning Methods," 10.30 a.m.; "A Comparison of Space Heating Systems," G. H. Buckle, 2.30 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., June 10.—Great George Street, Westminster, London, S.W.1, Annual General Meeting, 5.30 p.m.

INSTITUTION OF ENGINEERING DESIGNERS

Thurs., June 12.—1958 Lord Westwood Memorial Lecture: Manson House, 26, Portland Place, London, W.1, "Engineering Design—The Background and Basis of Contemporary Life," H. Clausen, 6.30 p.m.

INSTITUTION OF PUBLIC HEALTH ENGINEERS

Fri., June 13.—Caxton Hall, Westminster, London, S.W.1, Summer Meeting; Annual General Meeting, 4.45 p.m. "Hogsmill Valley Works of the Hogsmill Valley Joint Sewerage Board," 6 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN

Wed., June 11.—21, Albemarle Street, London, W.1, "Drilling Deep Holes into the Earth," T. H. Gaskell, 9 p.m.

ROYAL SOCIETY

Thurs., June 12.—Burlington House, Piccadilly, London, W.1, "The Nature of the Cosmic Radio Sources," M. Ryle, 4.30 p.m.

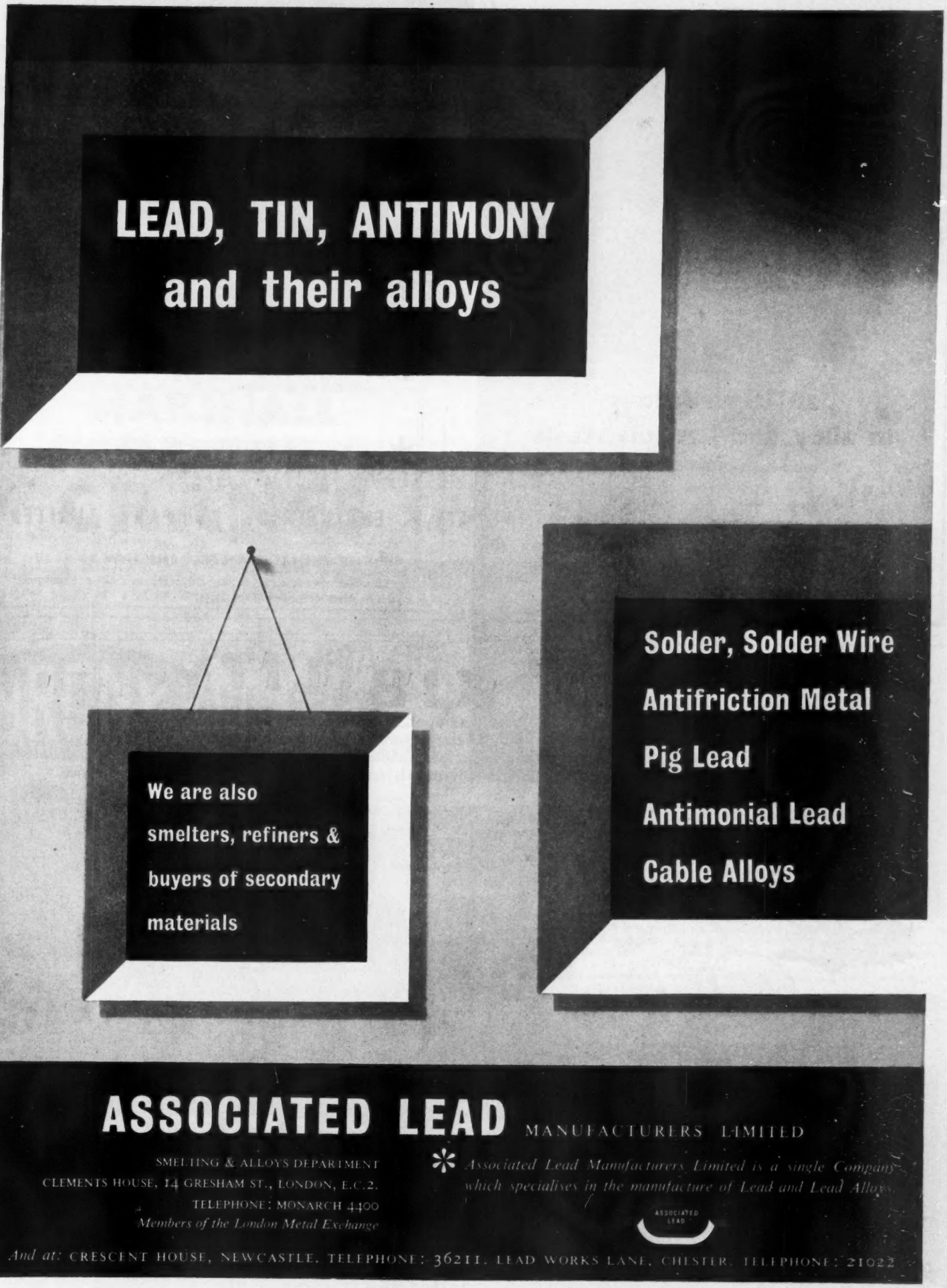
Advanced Engineering Courses

The Design of Industrial Experiments. INSTITUTE FOR ENGINEERING PRODUCTION, UNIVERSITY OF BIRMINGHAM, "Southfield," 16, Norfolk Road, Edgbaston, Birmingham, 15. Residential executive course. Monday, June 30 to Friday, July 4. Fee thirty guineas.

Control and Instrumentation of Reactors. REACTOR SCHOOL, ATOMIC ENERGY RESEARCH ESTABLISHMENT, Harwell, Berkshire. Monday, October 6, to Saturday, October 11. Fee twenty-five guineas.

Standard Reactor School Course. HARWELL REACTOR SCHOOL, ATOMIC ENERGY RESEARCH ESTABLISHMENT, Harwell, Berkshire. The first six weeks of the course, commencing September 1, will be held jointly at Birmingham, Bradford and Salford Colleges of Advanced Technology, the remaining part of the course, commencing October 15, will be at Harwell Reactor School. The course finishes on December 23. Fee £250.

Statistical Quality Control and Acceptance Sampling. COLLEGE OF TECHNOLOGY, Gosta Green, Birmingham 4. Three-week course, commencing Monday, September 8. The first two weeks will be devoted to the general principles and procedures involved, and the final week will be devoted to lectures by specialists from industry and to visiting the works of firms employing quality control.



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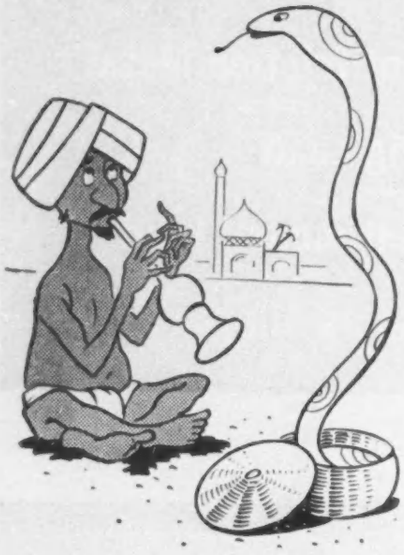

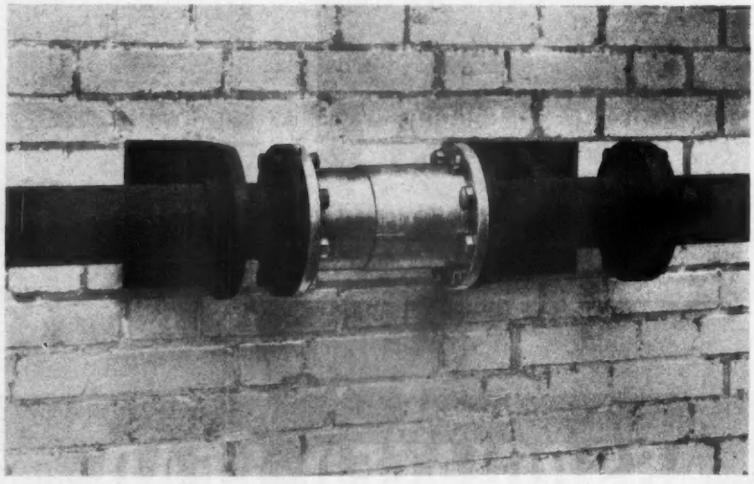

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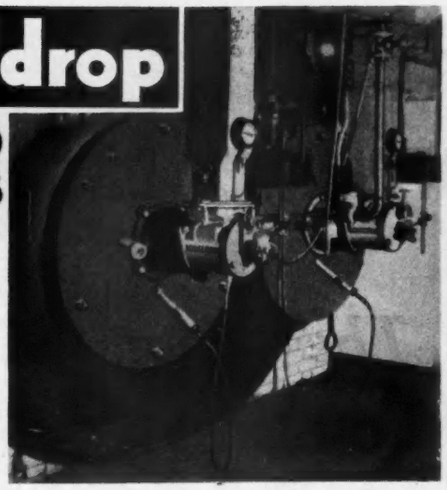

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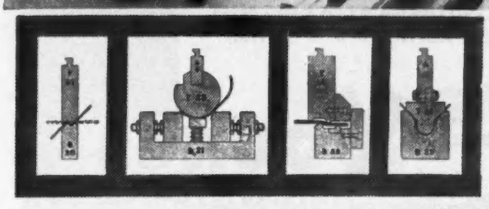

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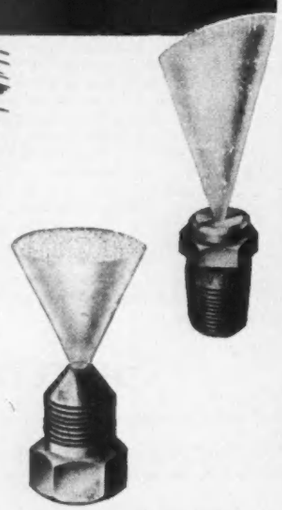

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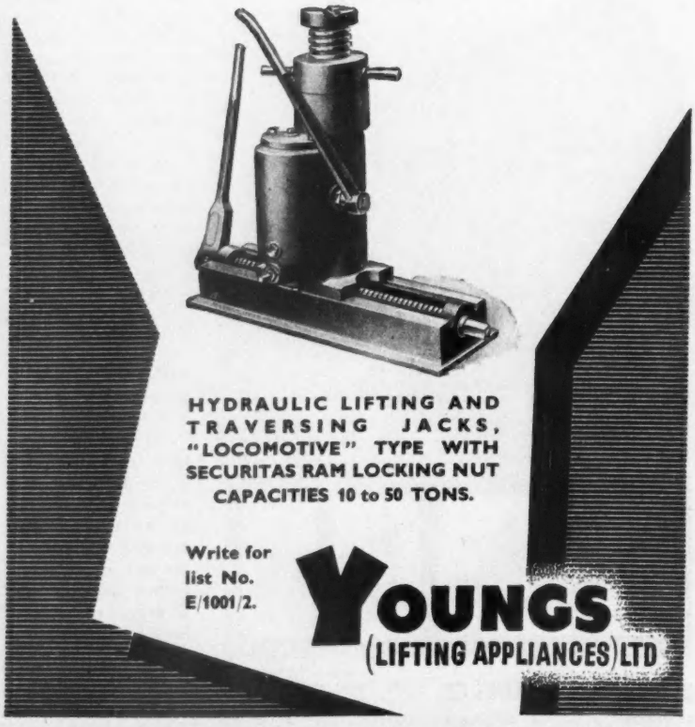

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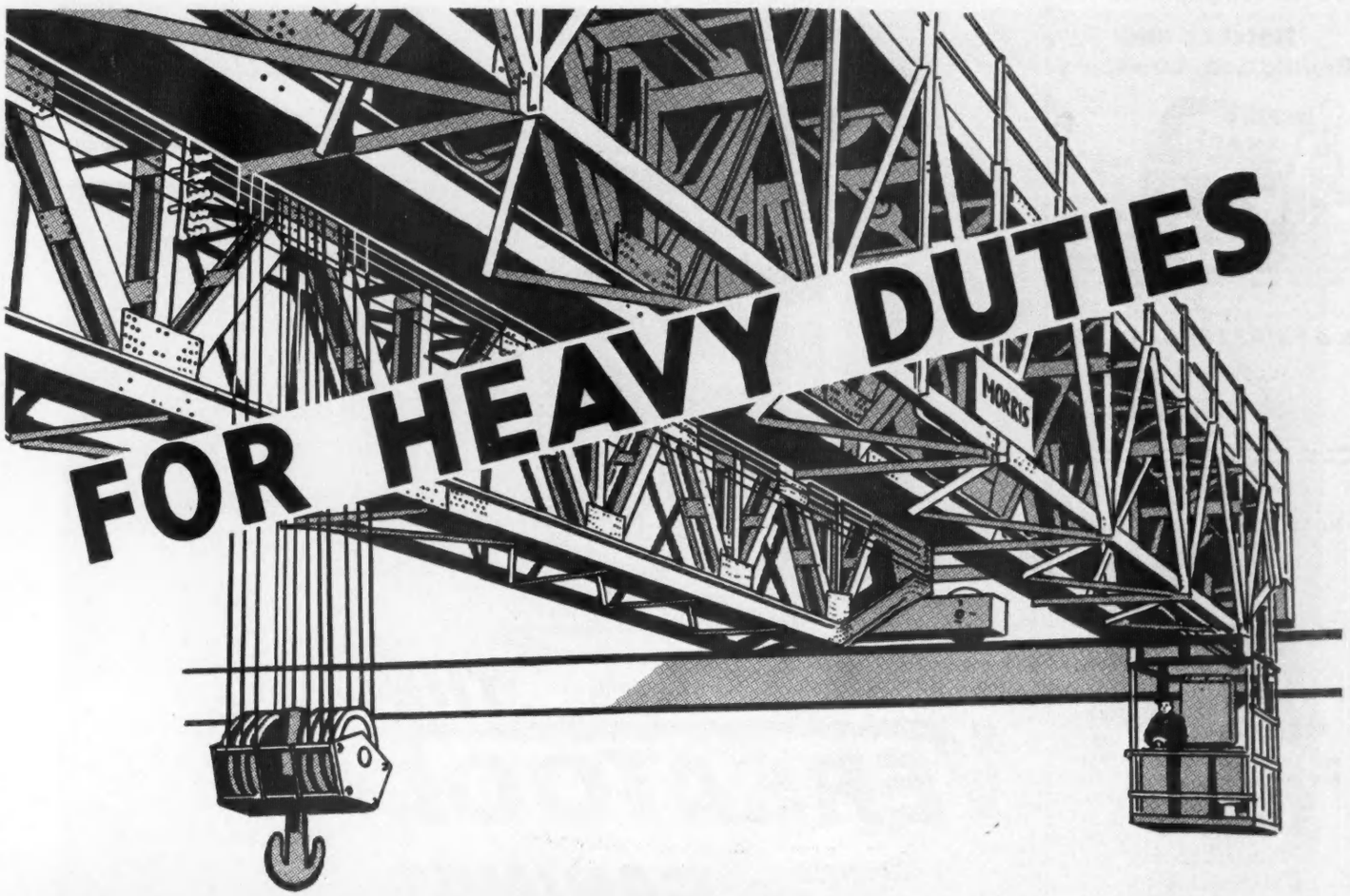

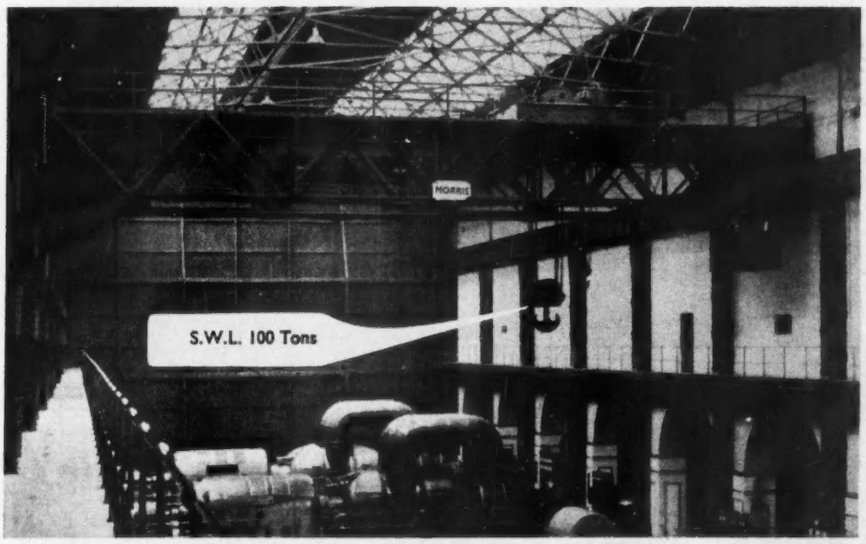

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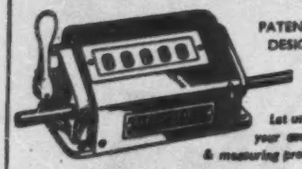

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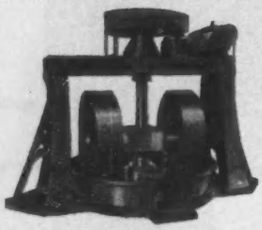

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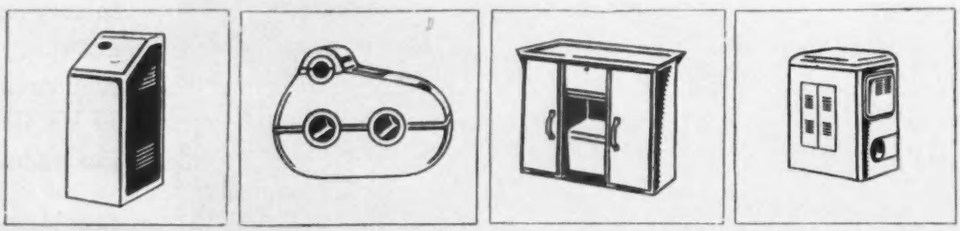

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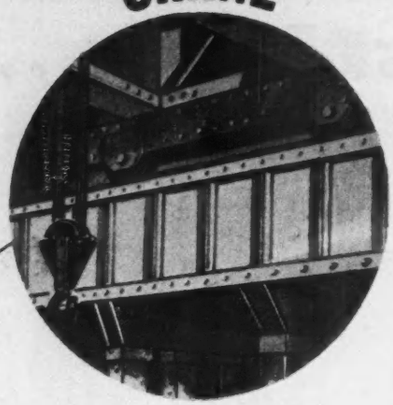

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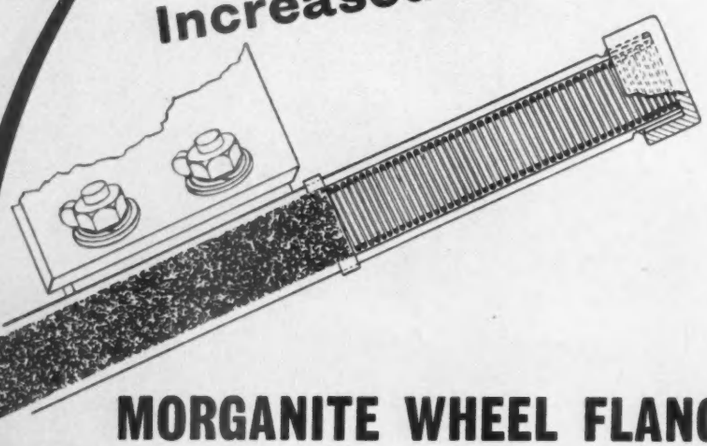

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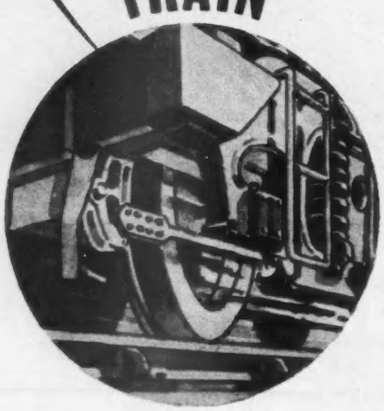

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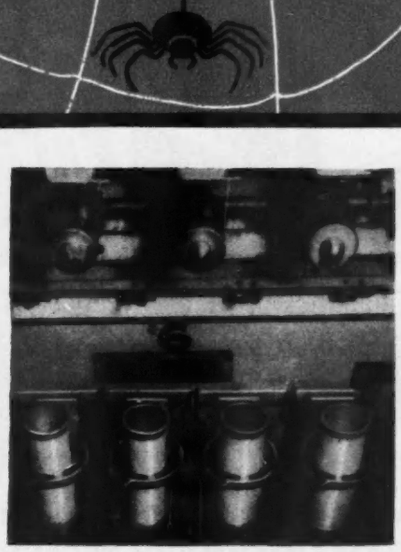

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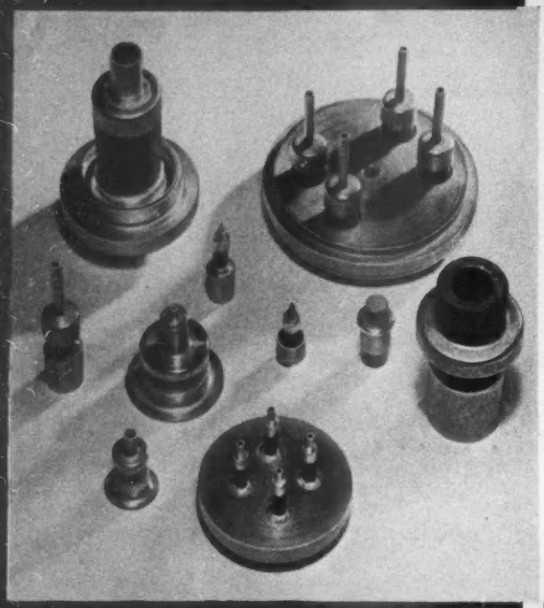

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Operating Pressure.....at least 100 atmospheres, depending on direction of compression.

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Terminations for single and multicore cables.
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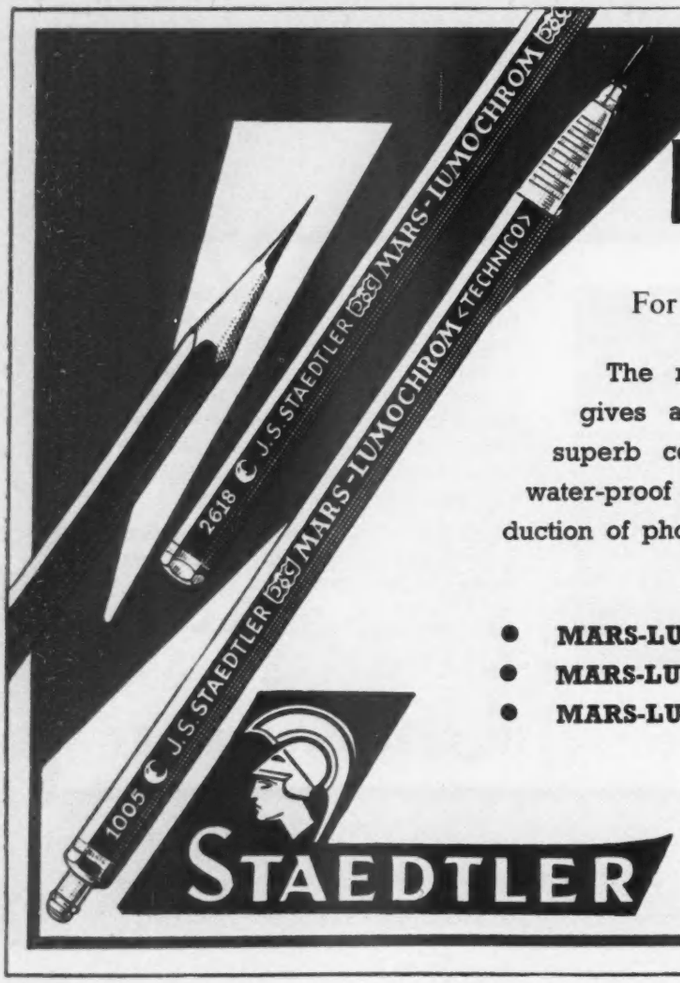

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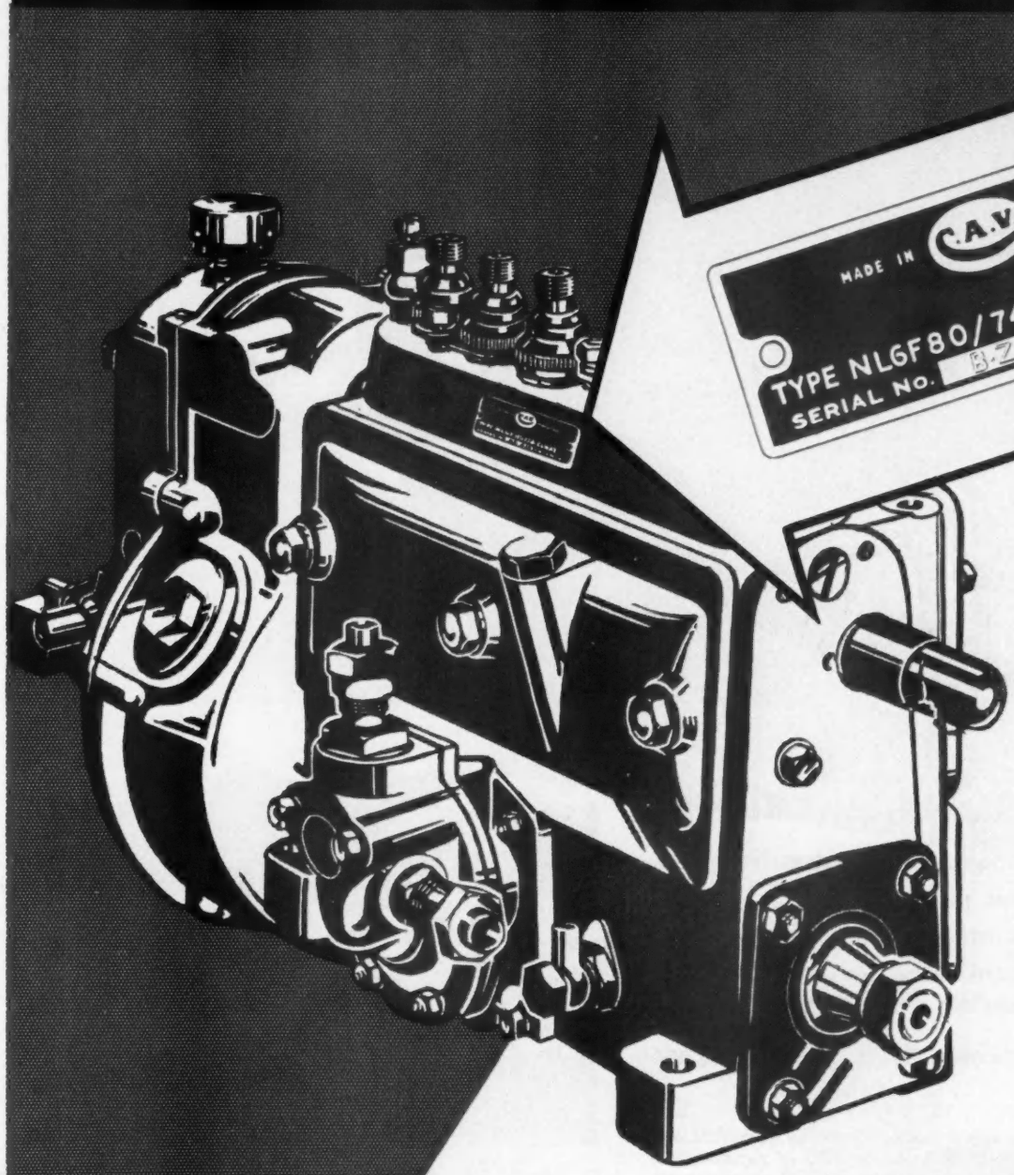

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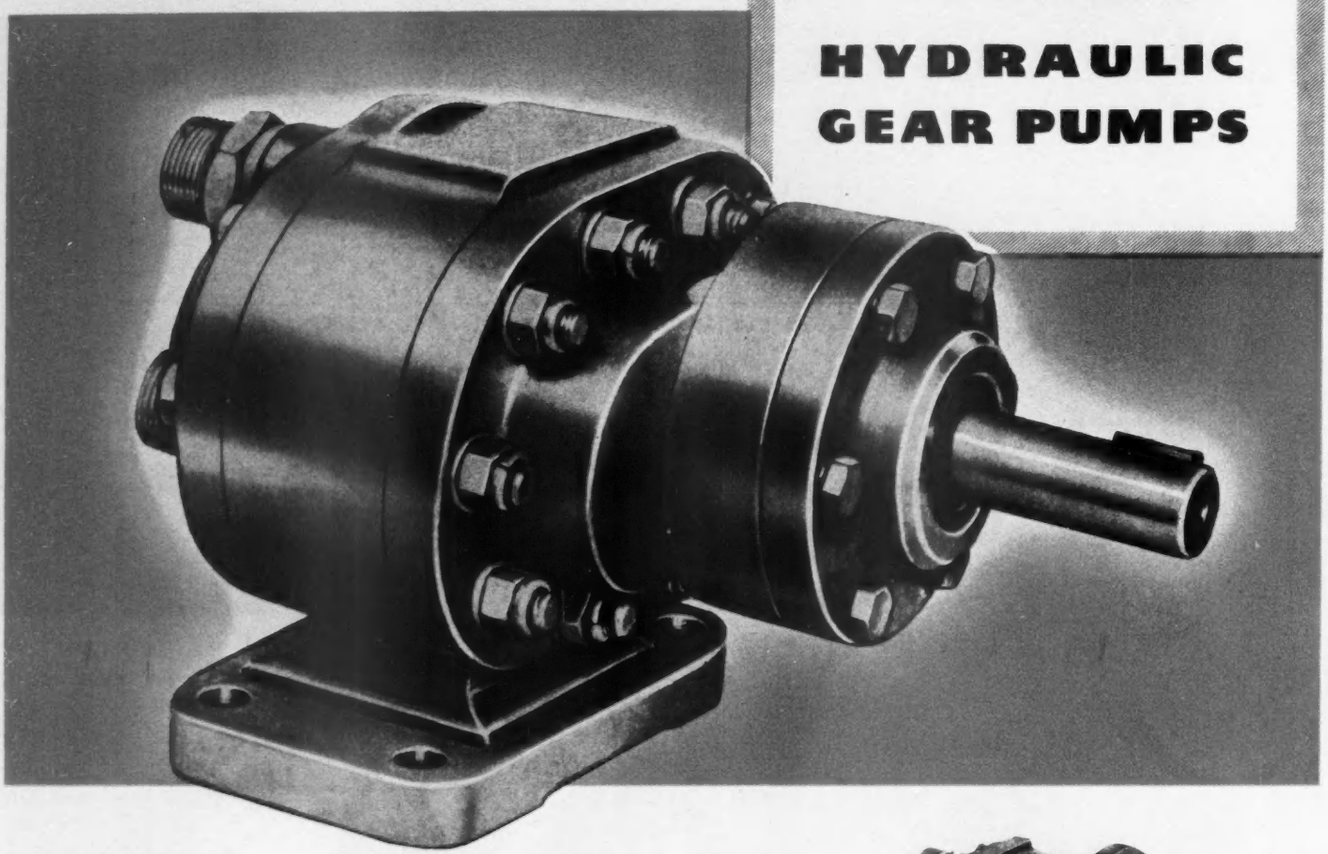

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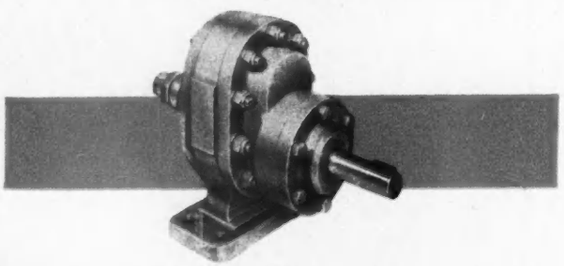

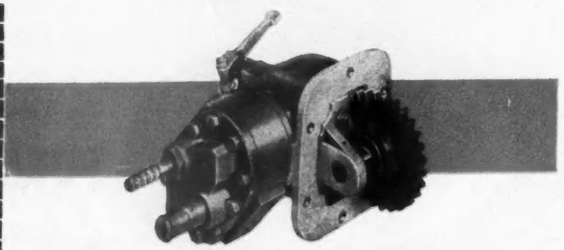

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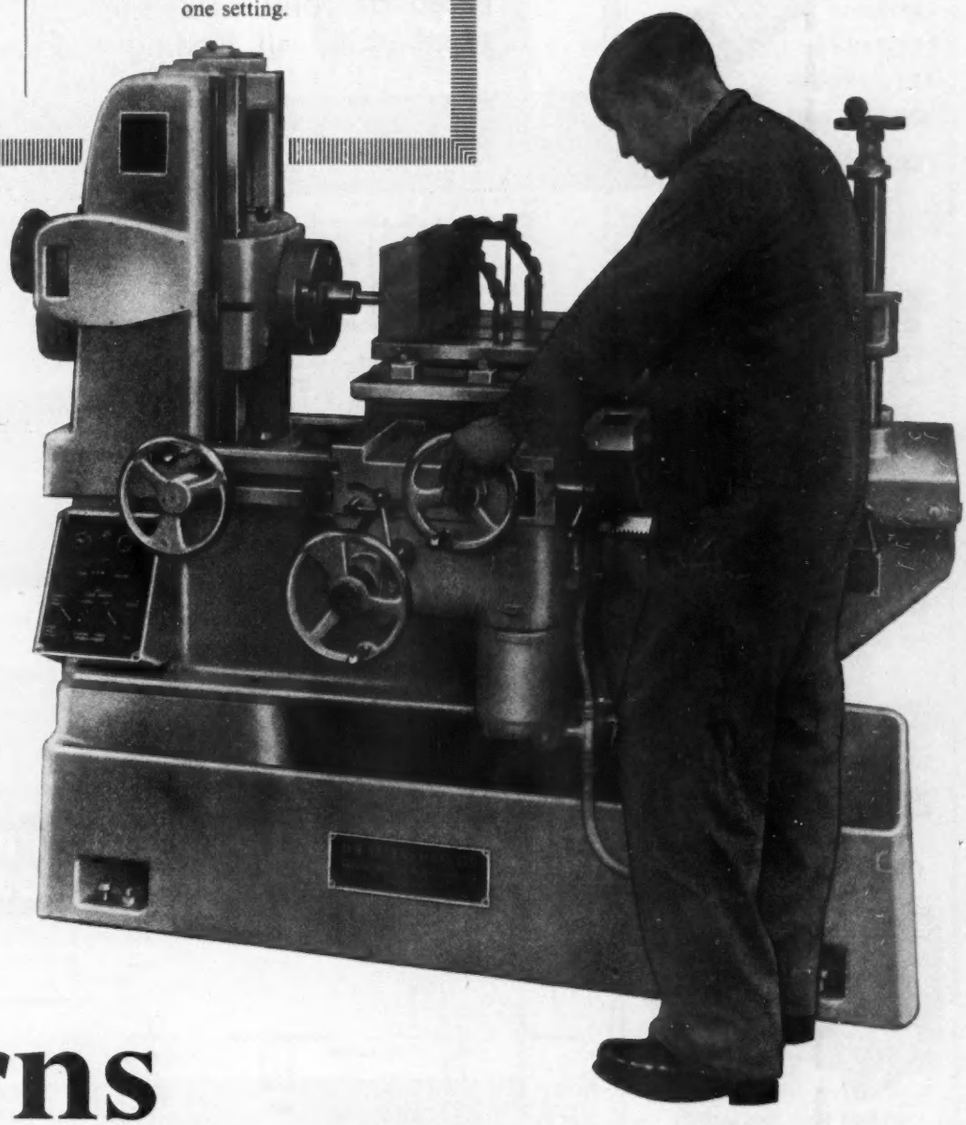

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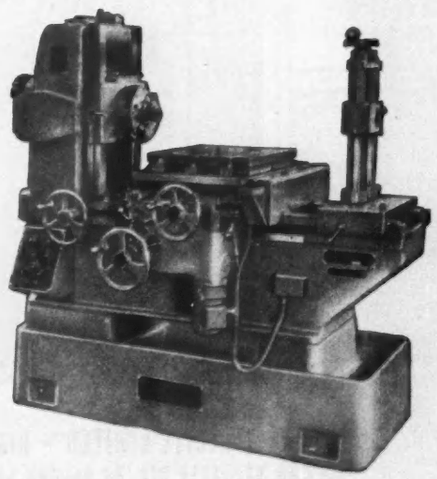

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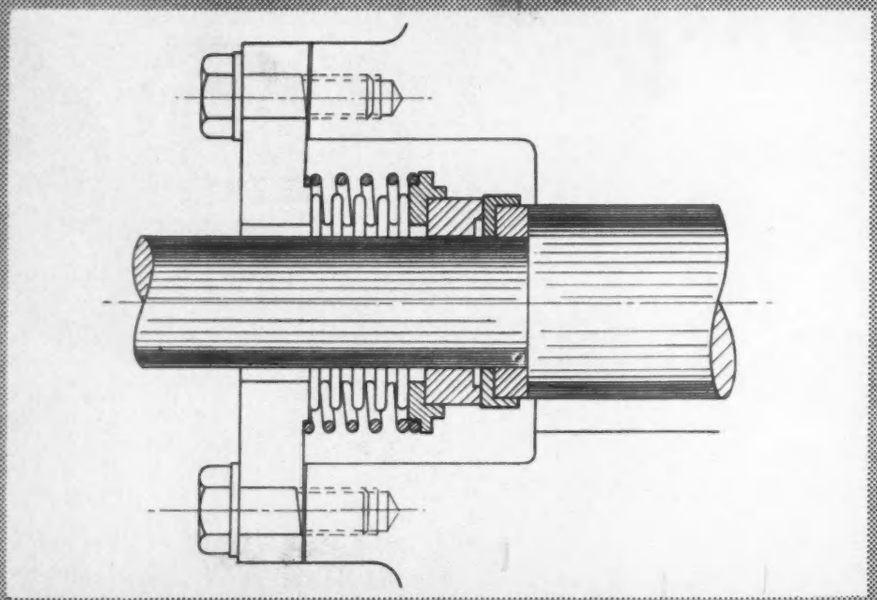

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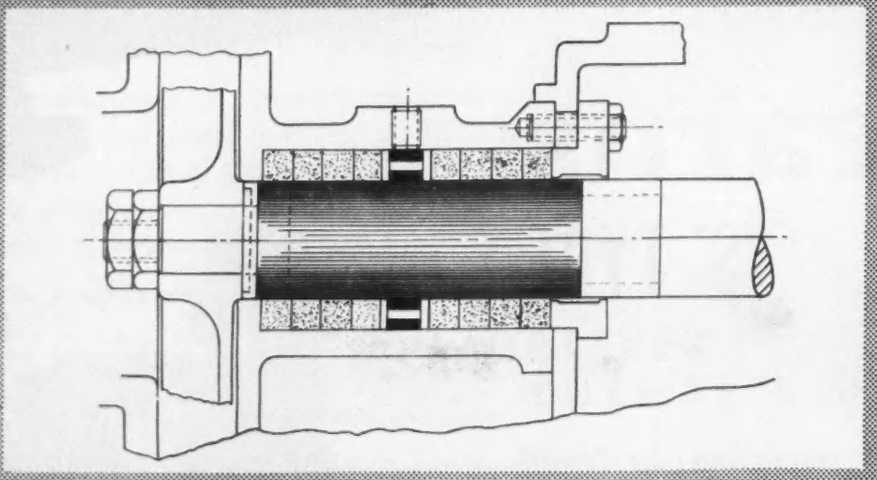

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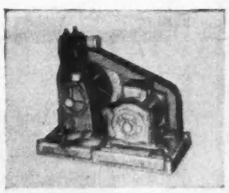

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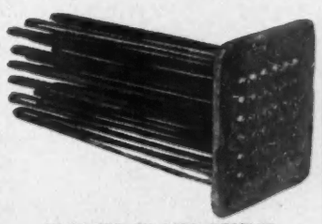

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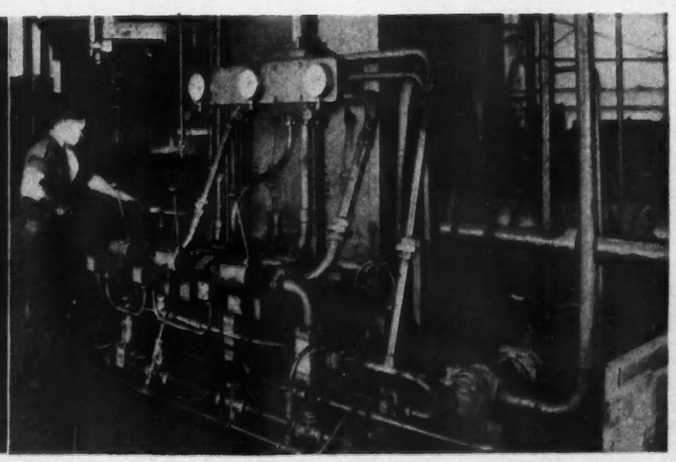

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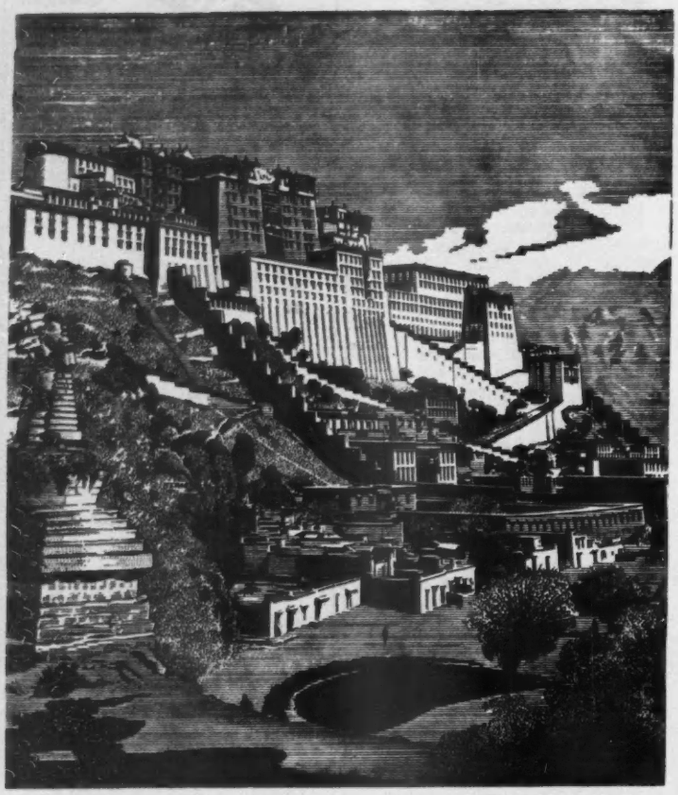

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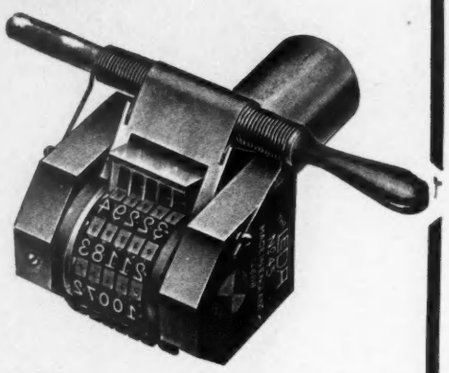

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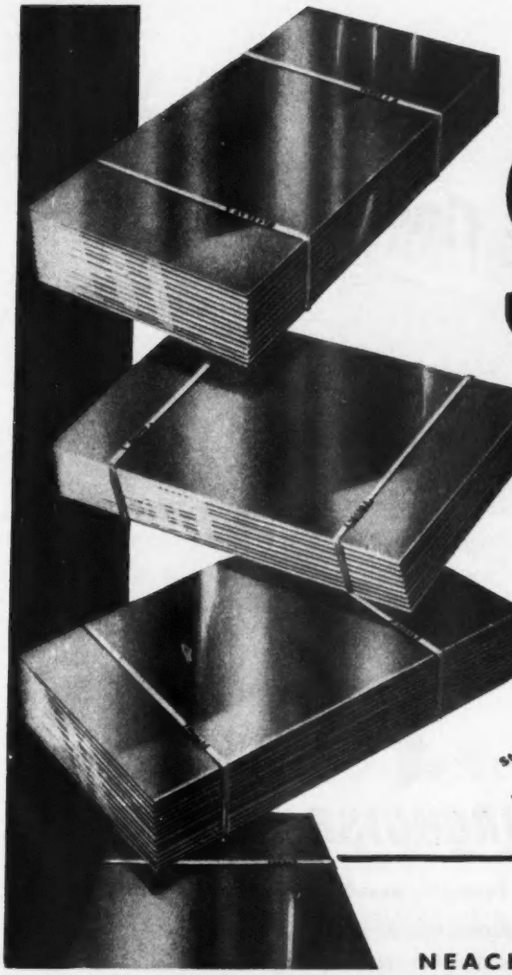

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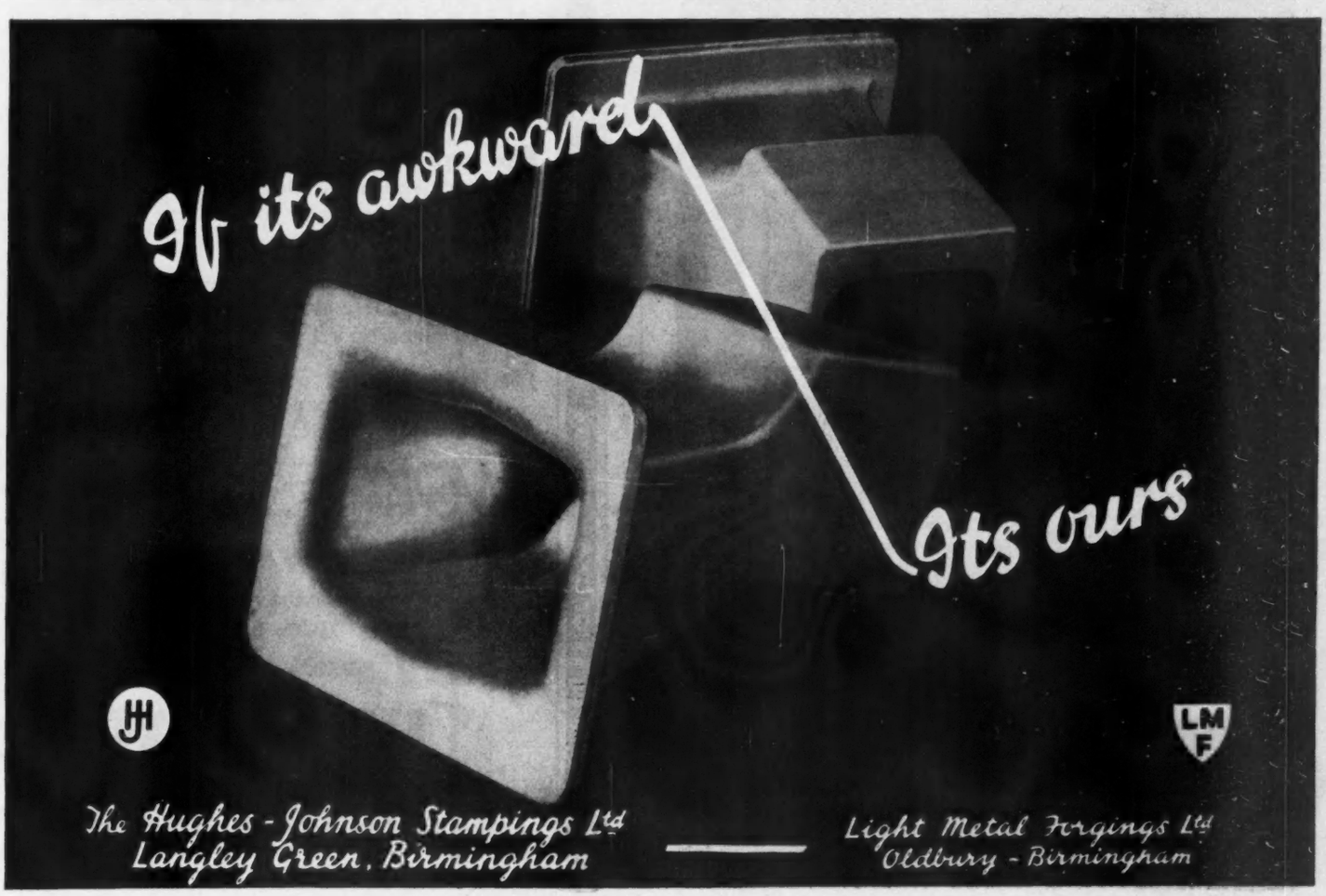

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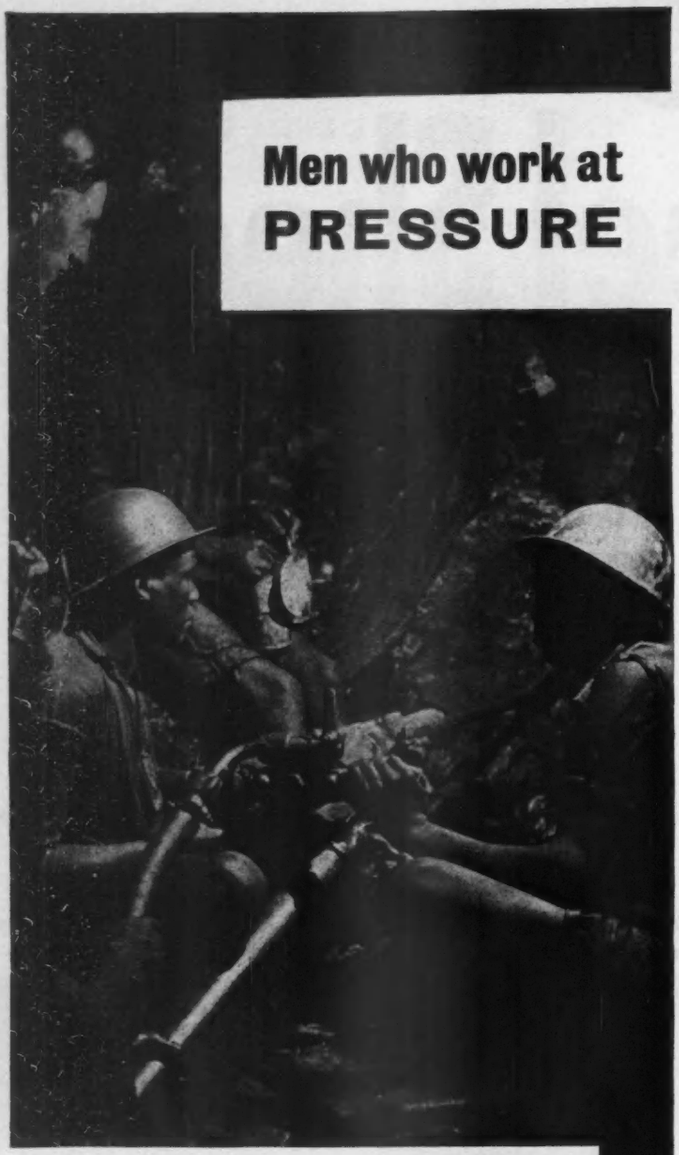

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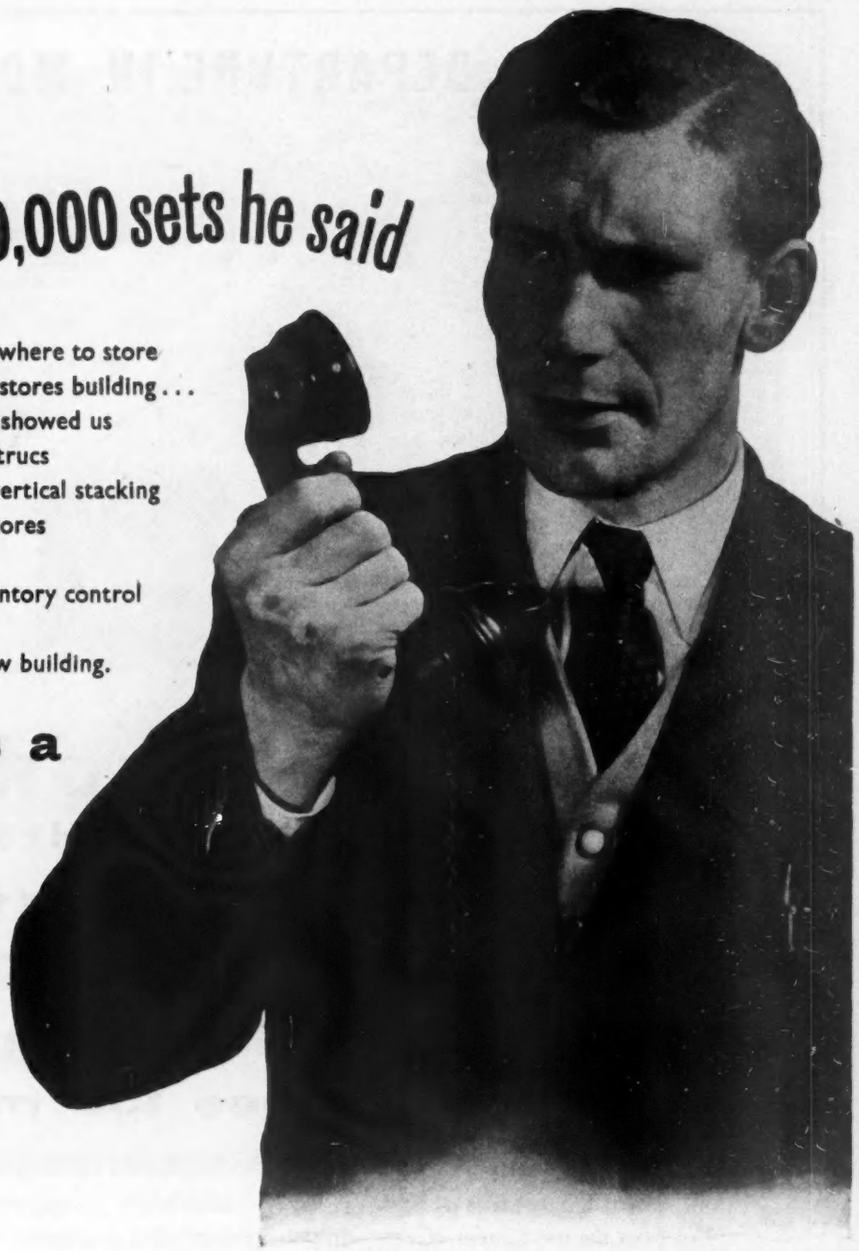

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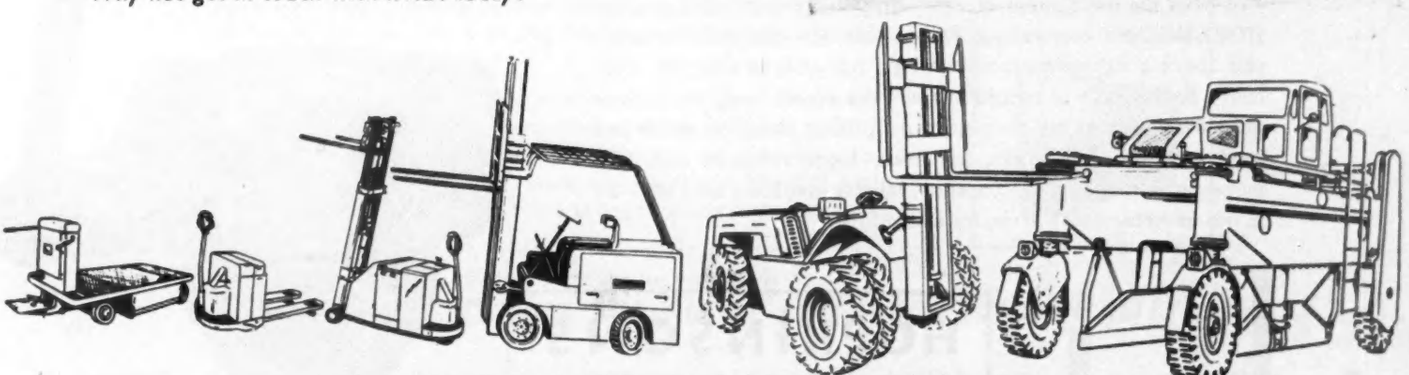

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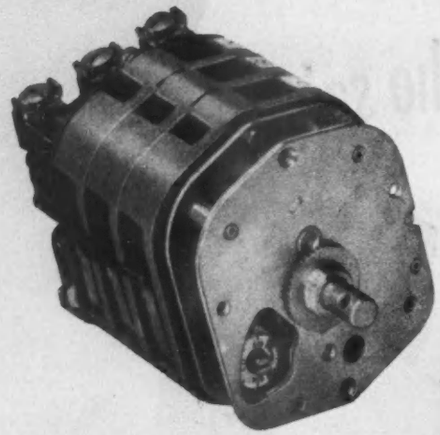

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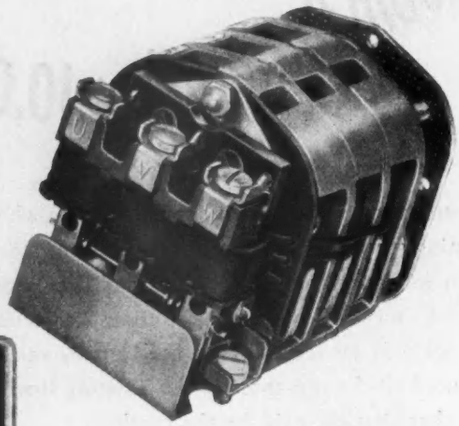

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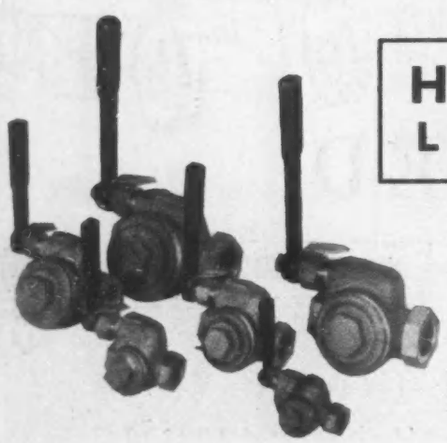

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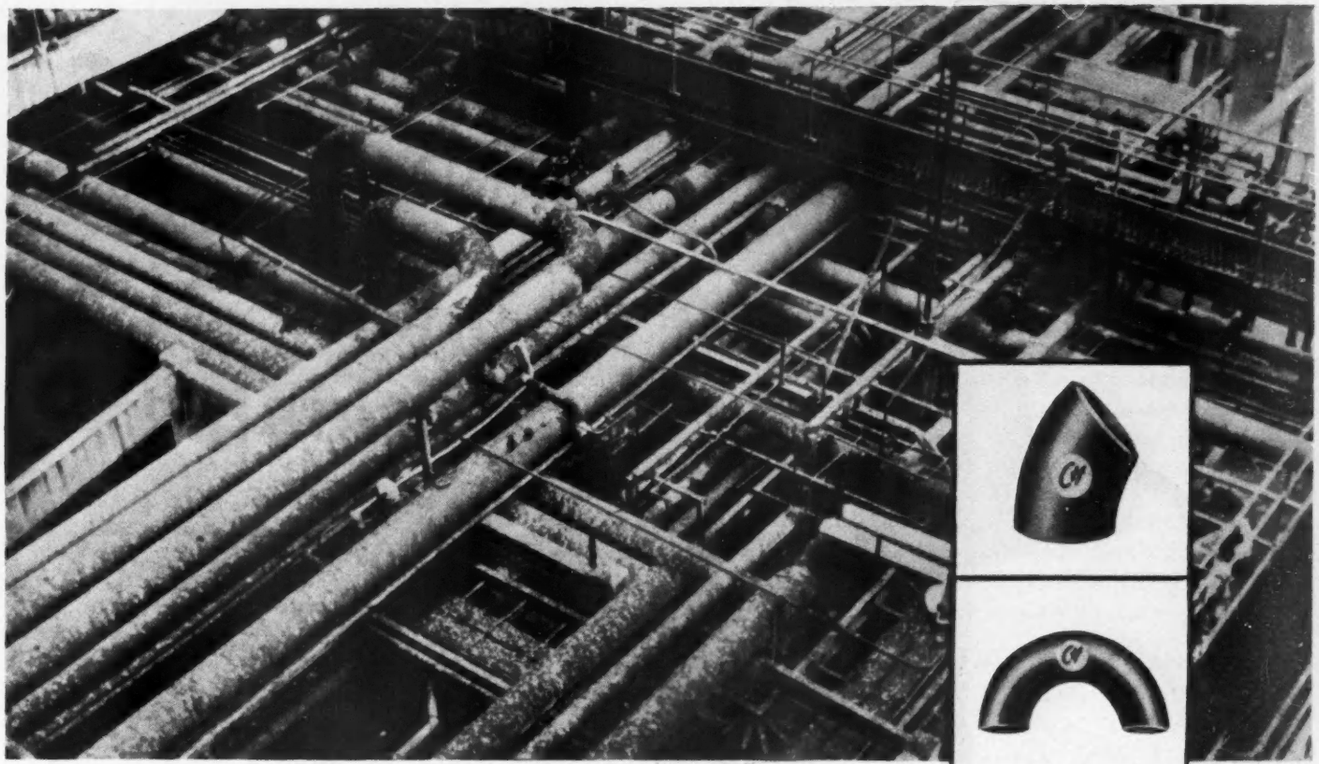

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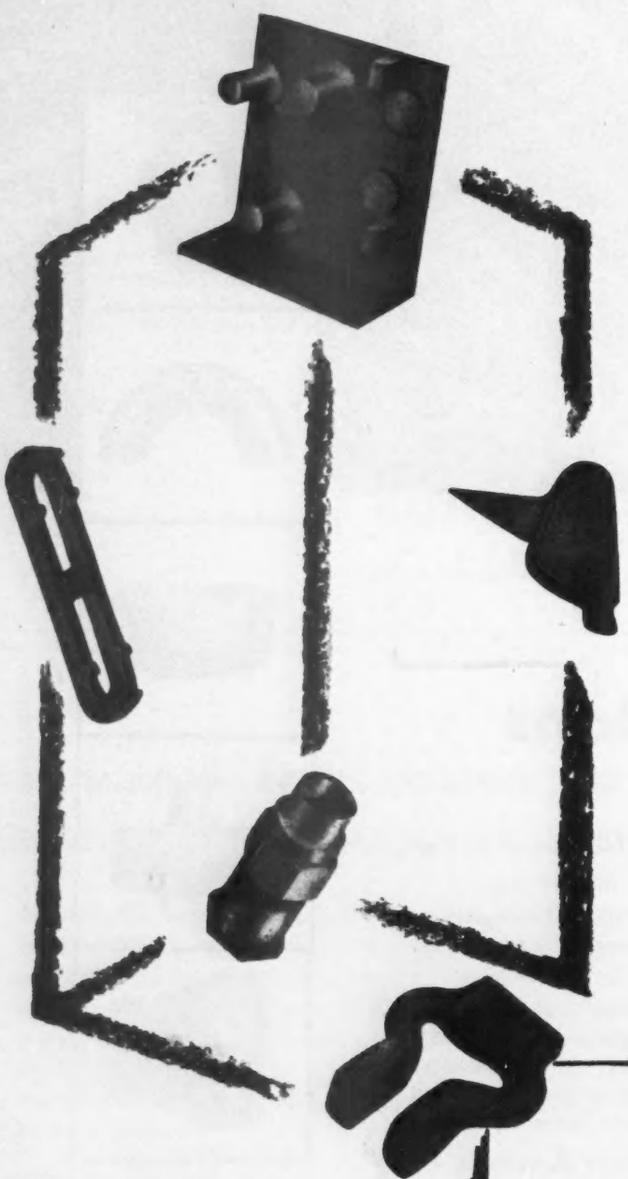

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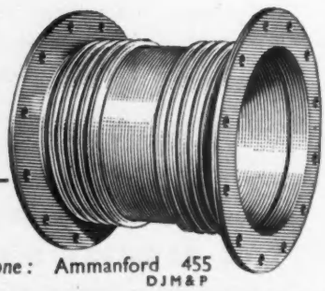

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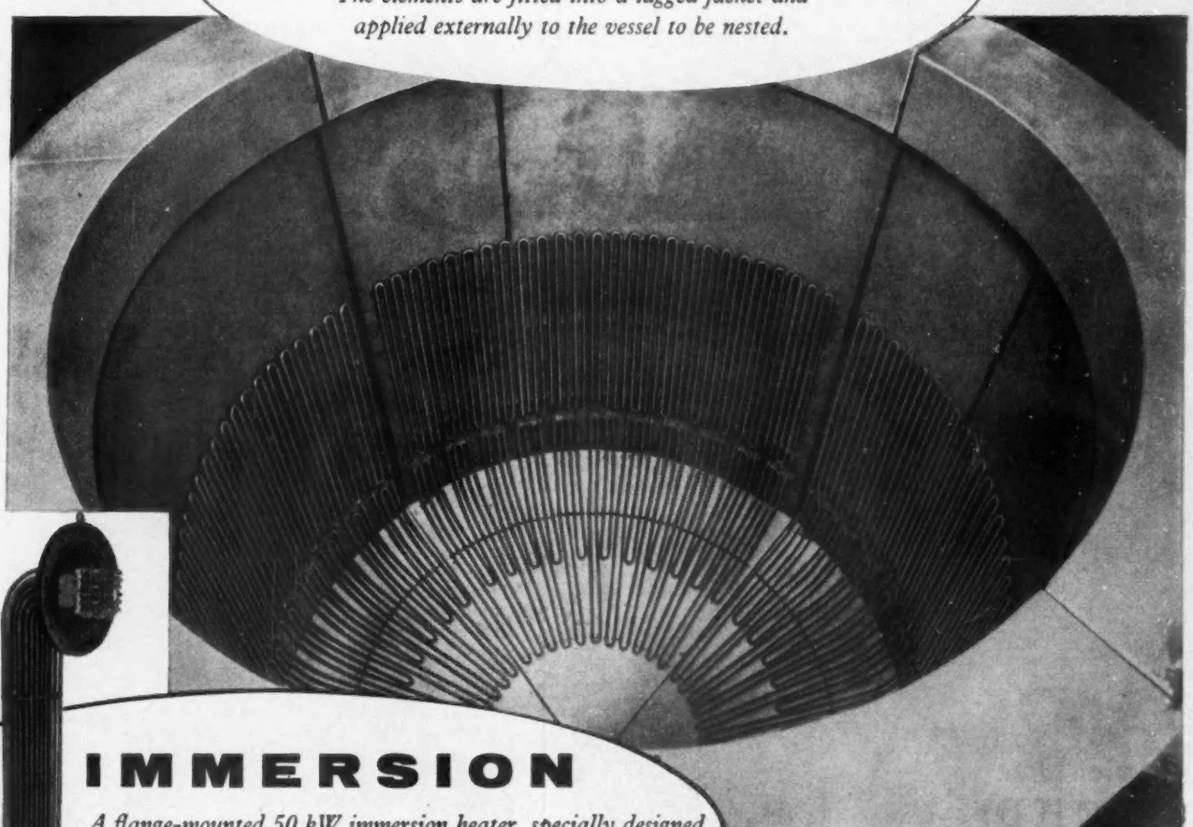

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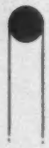

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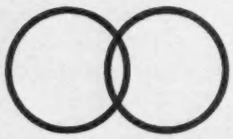

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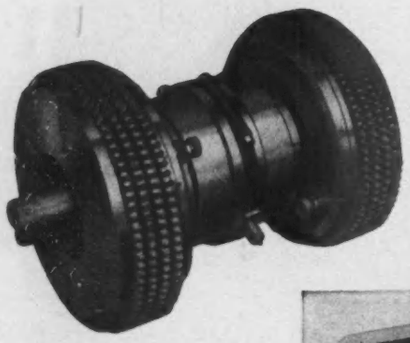

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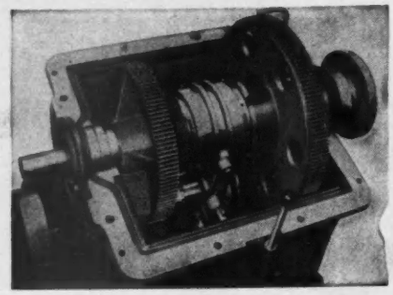

The illustrations show a typical application. The Reid Gear Co., Ltd., required a powerful, sensitive and completely trustworthy clutch unit for their two-speed reduction gear, to transmit the enormous effort applied in actuating the emergency sluice gate on a Scottish Hydro-Electric Project. The features mentioned above qualify Taylor Clutches to satisfy such exacting demands because they constitute the very ingredients of strength and reliability—the choice was a Taylor Multiple Disc Clutch.

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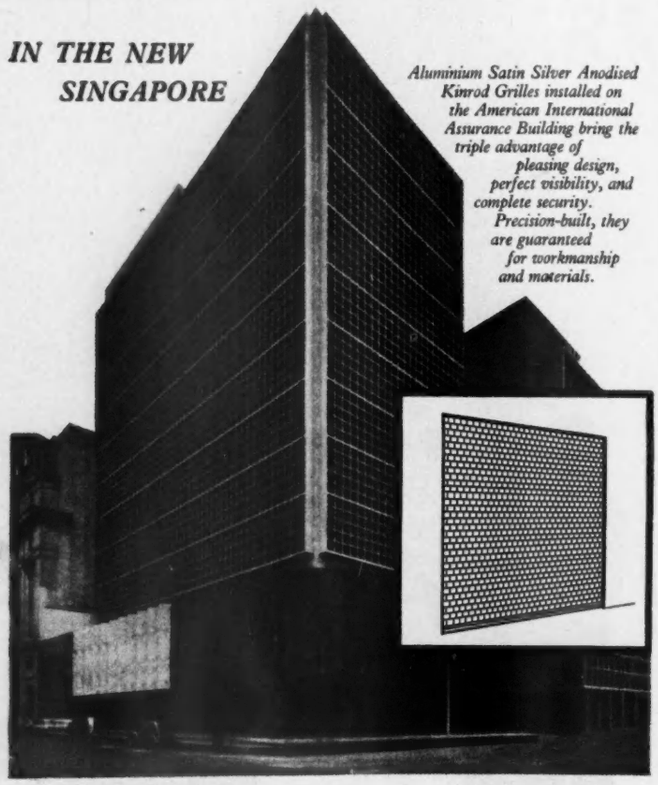

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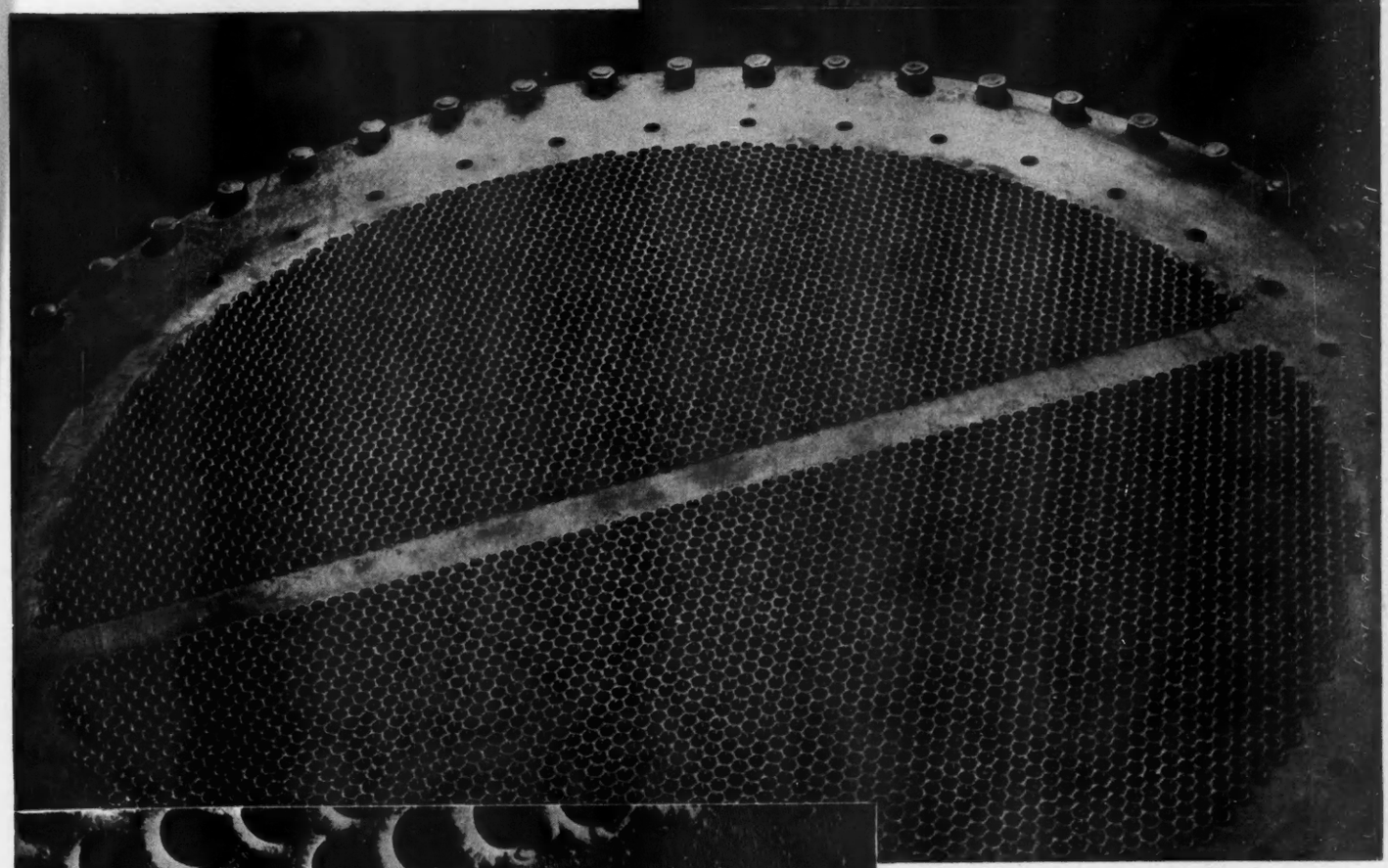

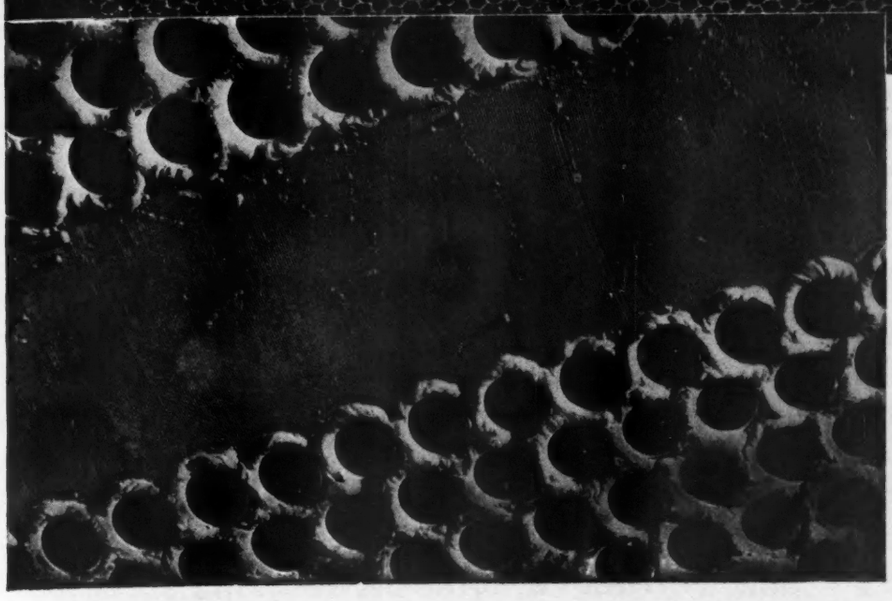

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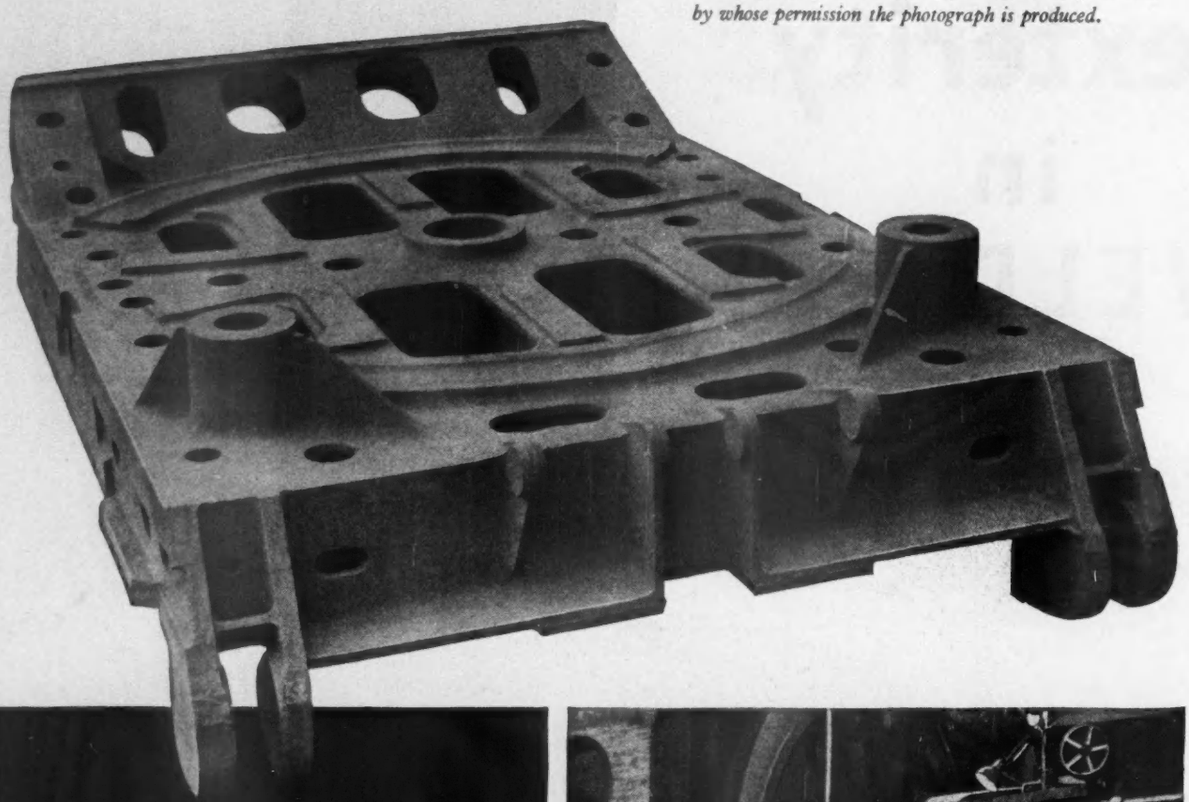
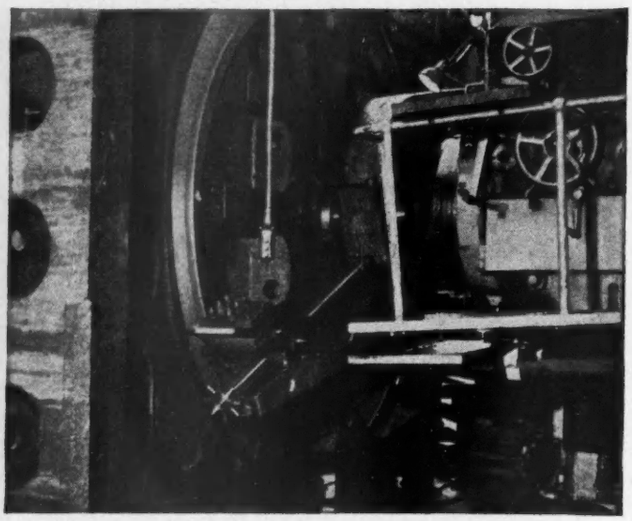
Revolving frame steel casting for the 150-RB excavator, size 10 ft. x 15ft. 6 ins. Cast for Ruston-Bucyrus Ltd. by whose permission the photograph is produced.



cast and machined for an important part



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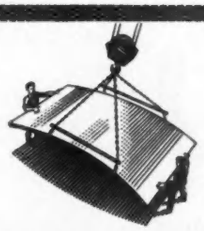

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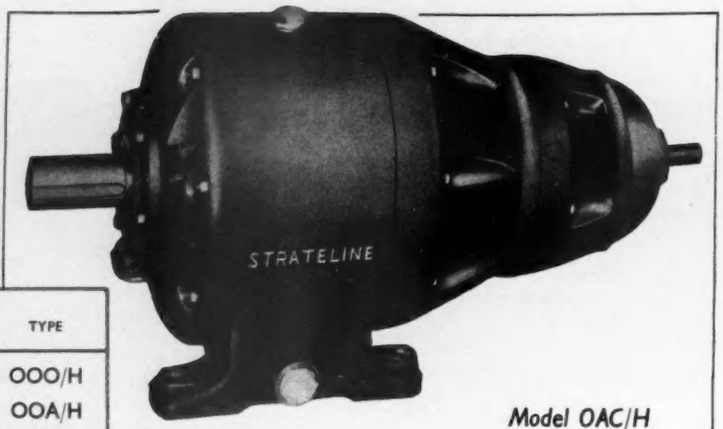

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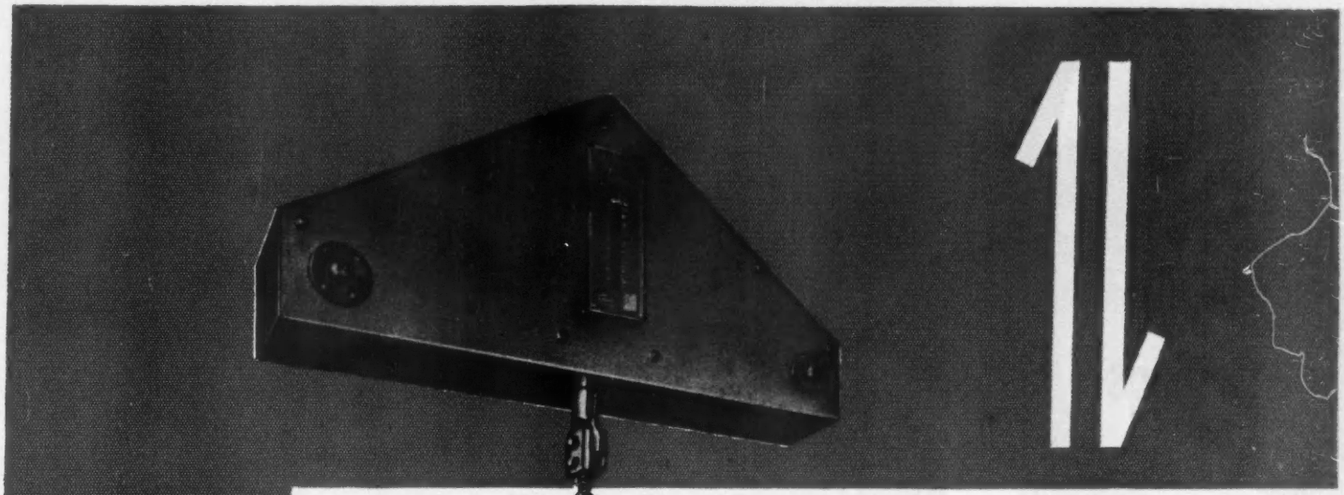

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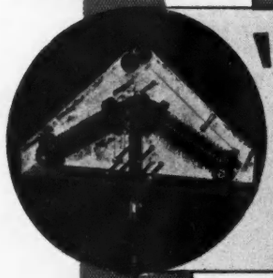

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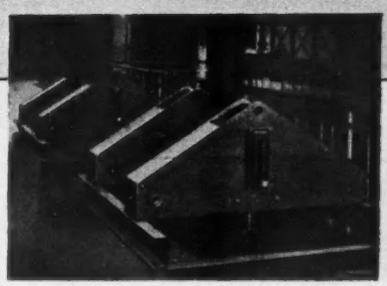

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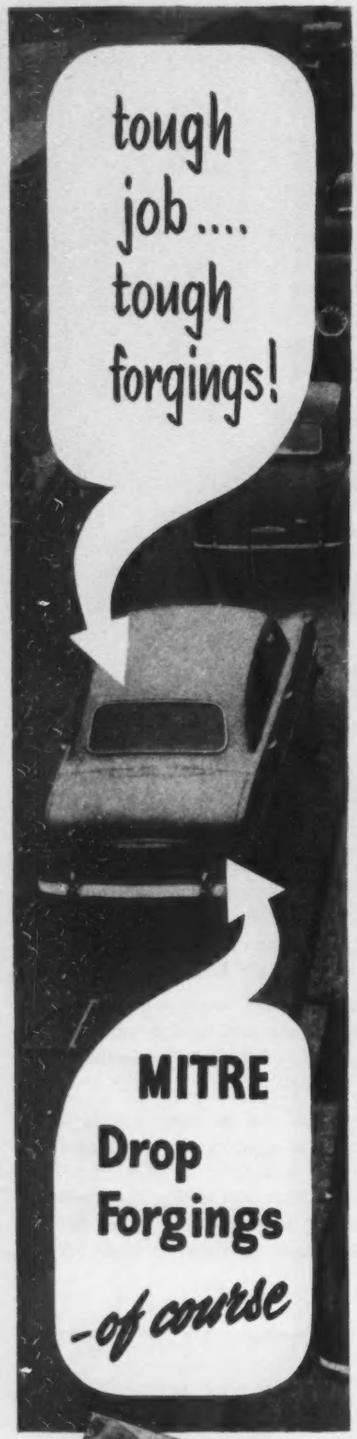

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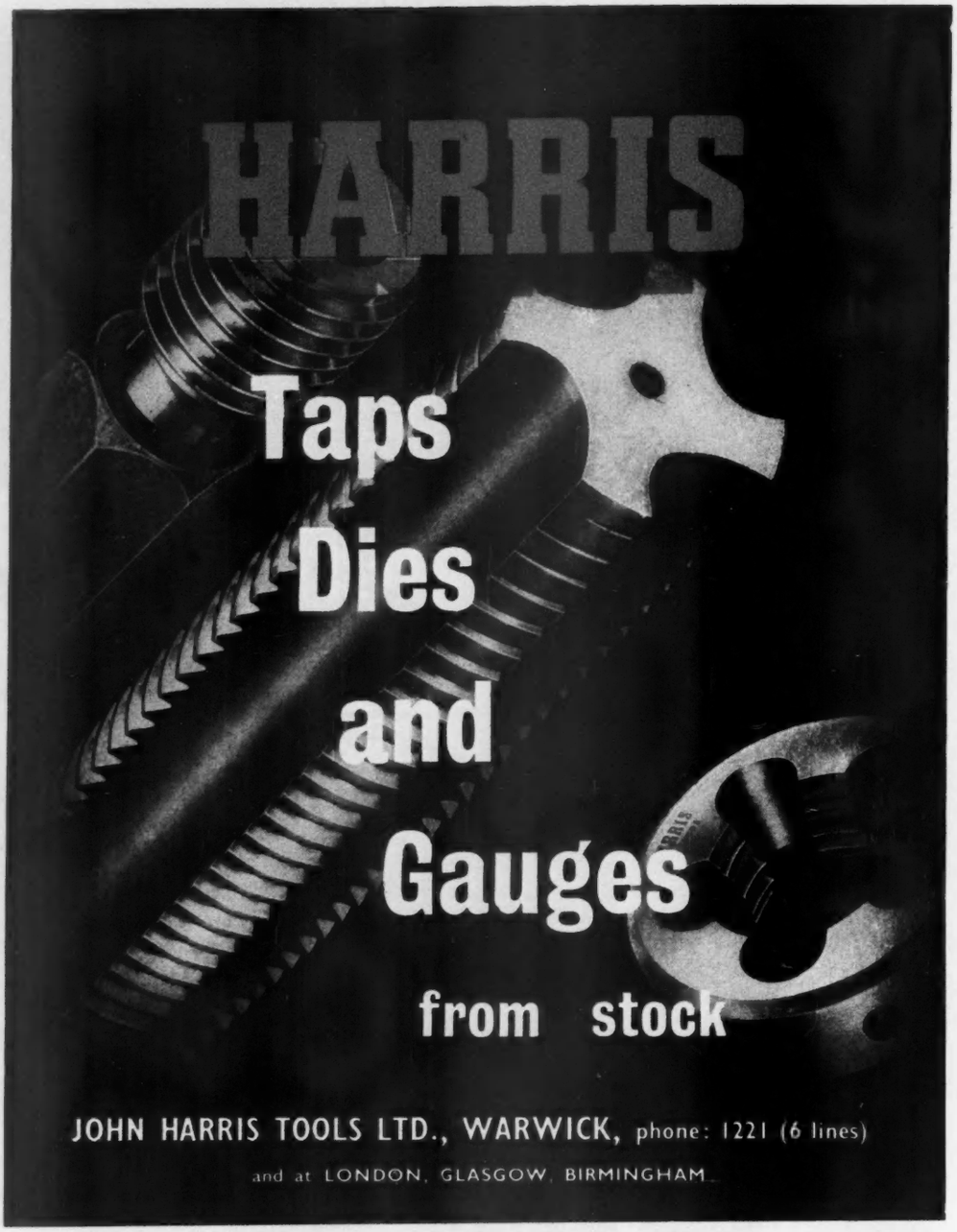

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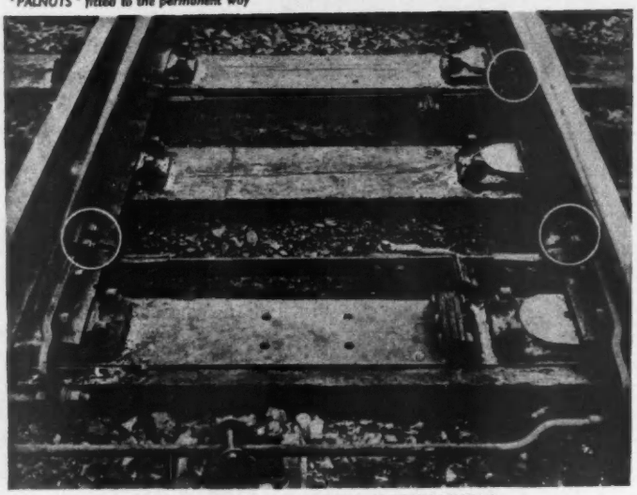

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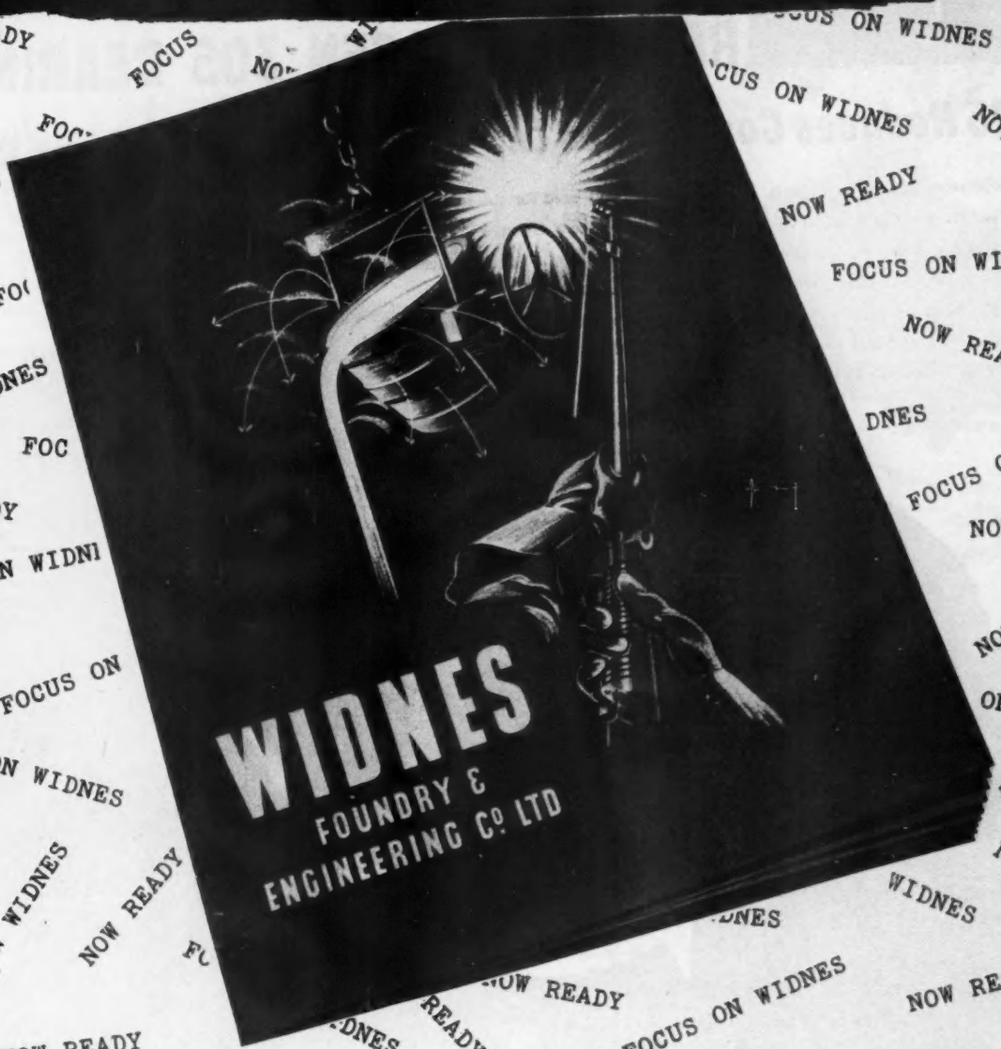

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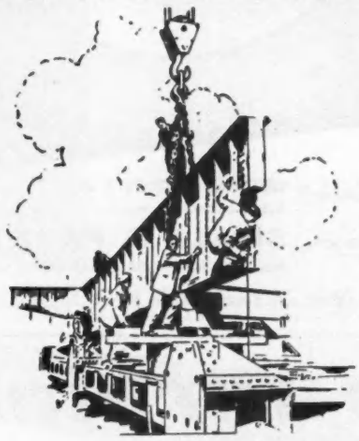

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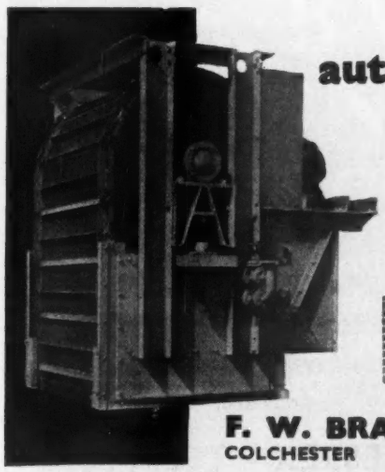

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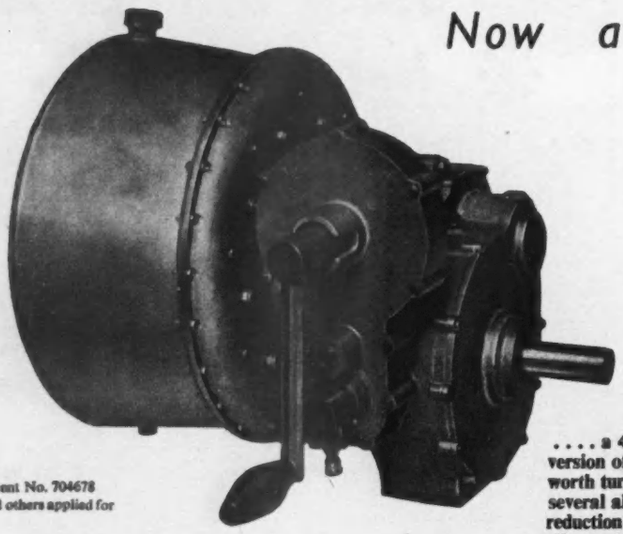

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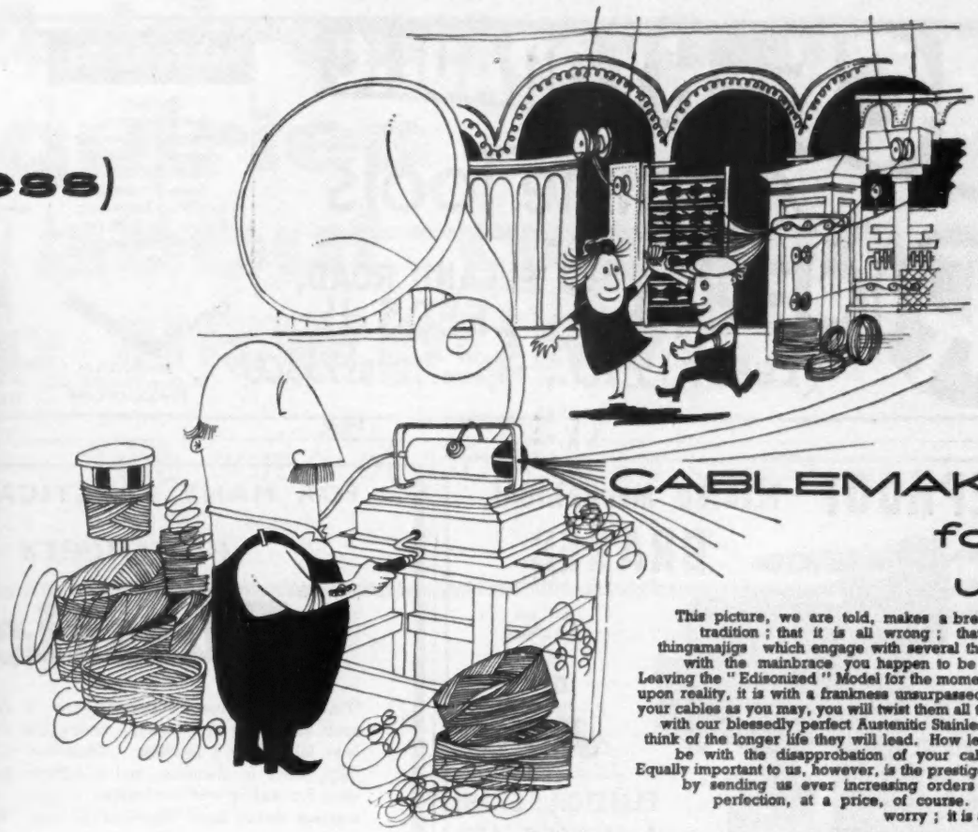

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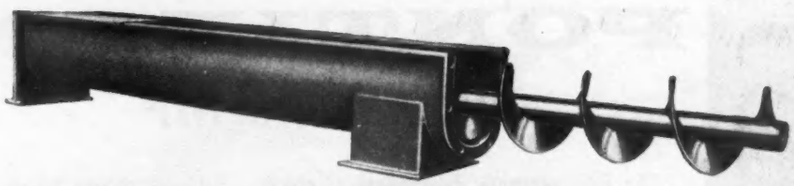

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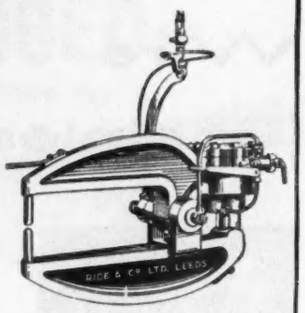

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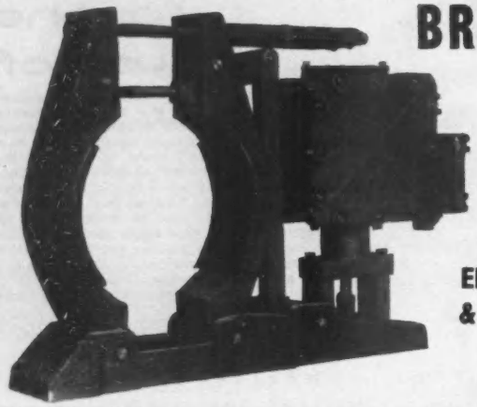

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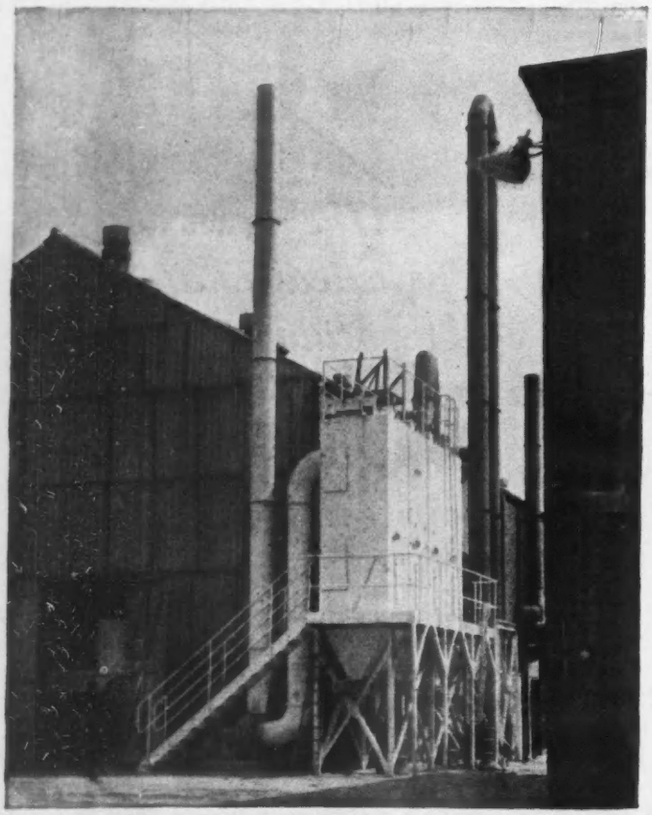

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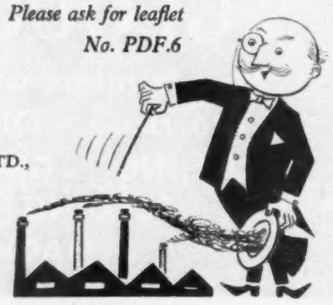

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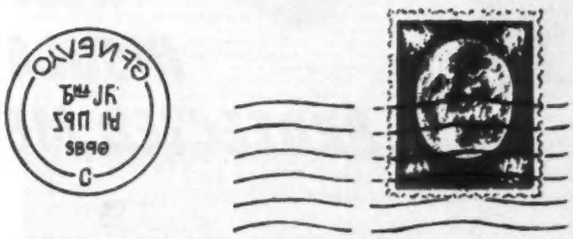

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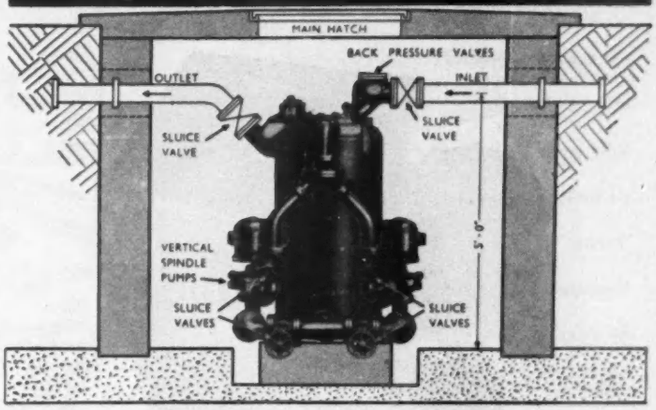

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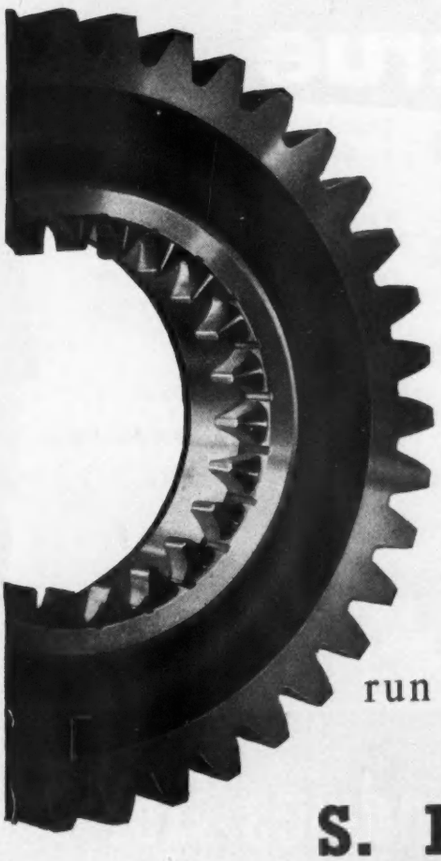

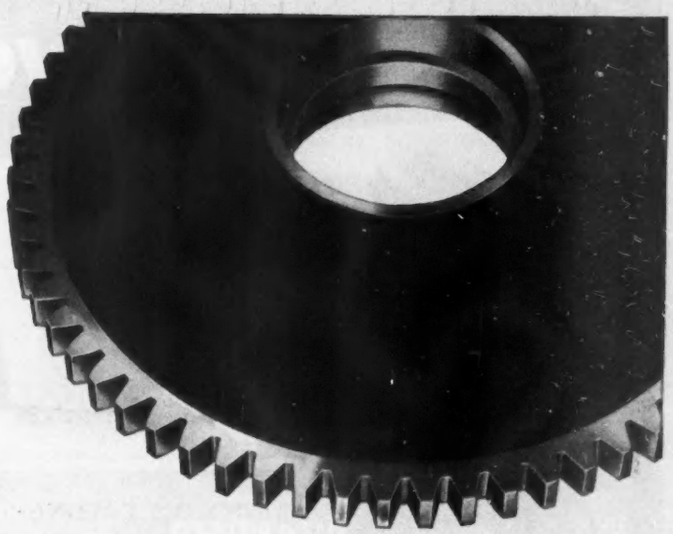

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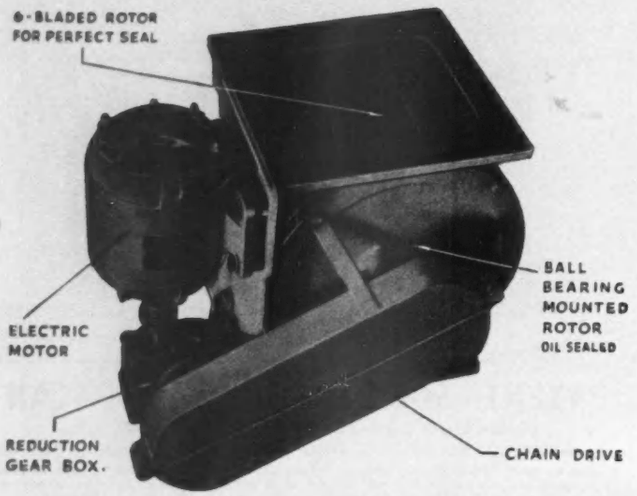

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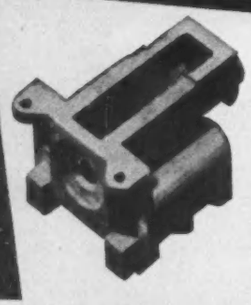

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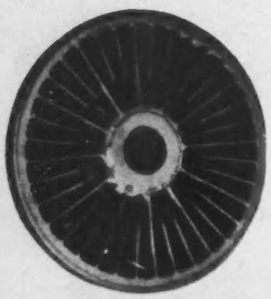

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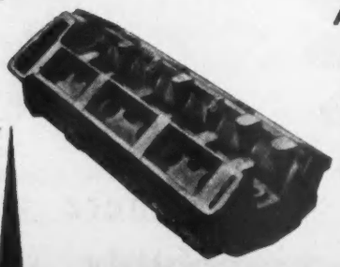

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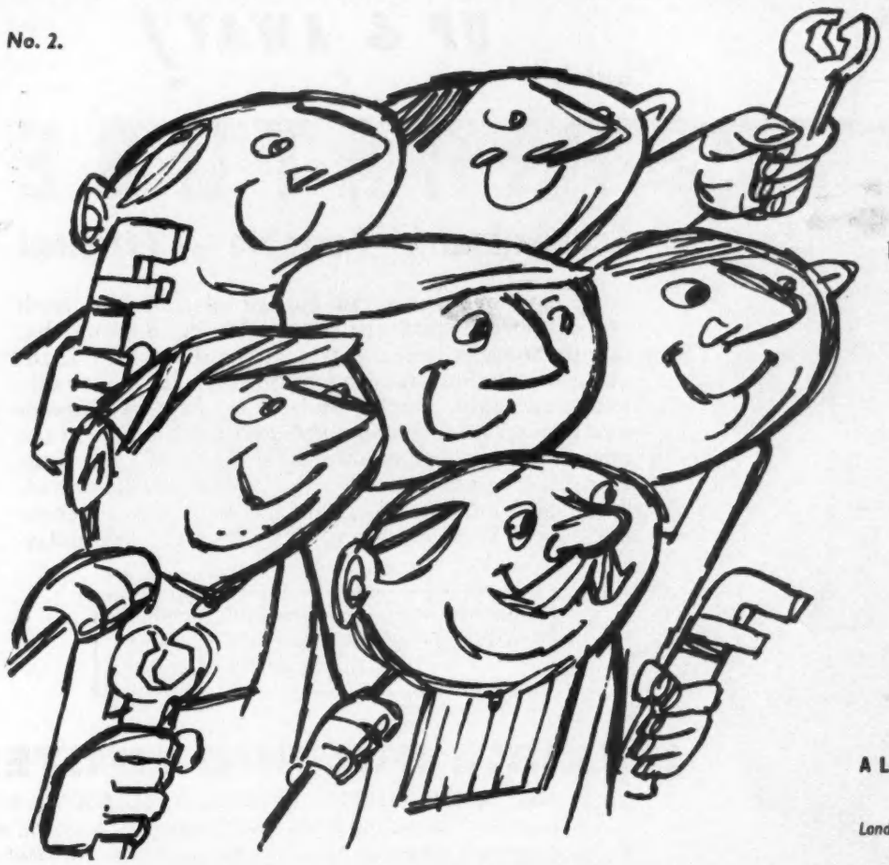

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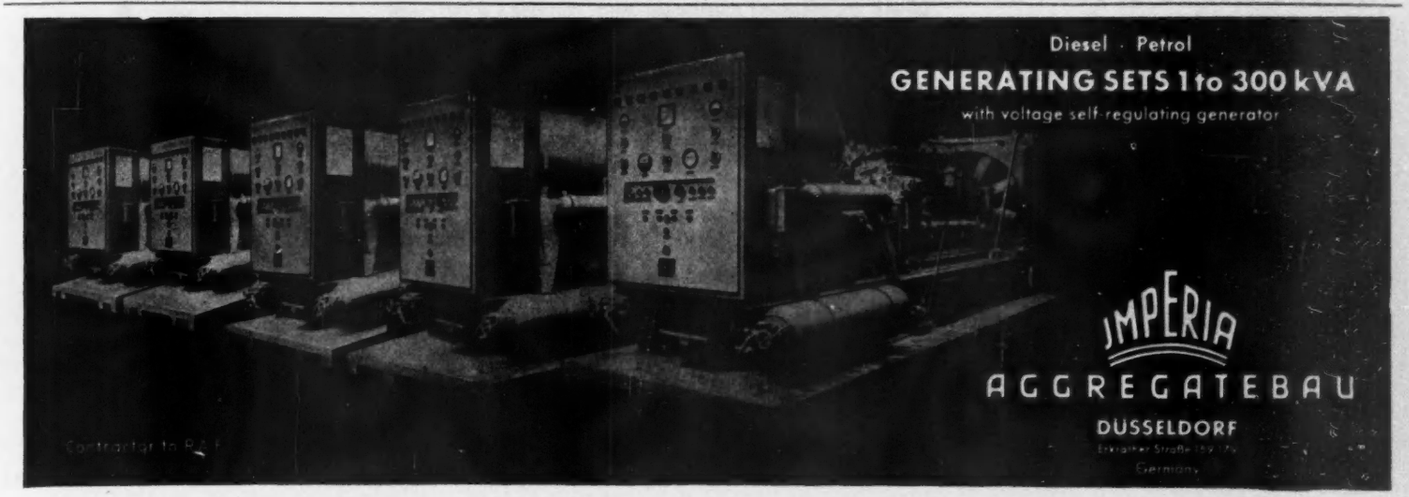

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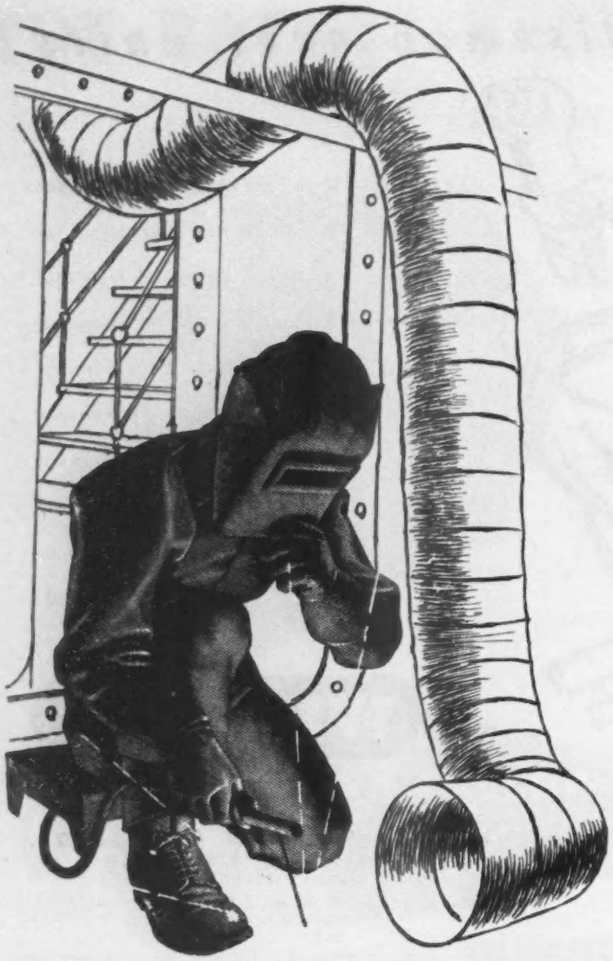

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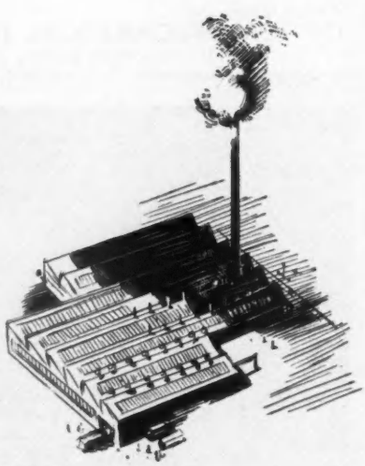

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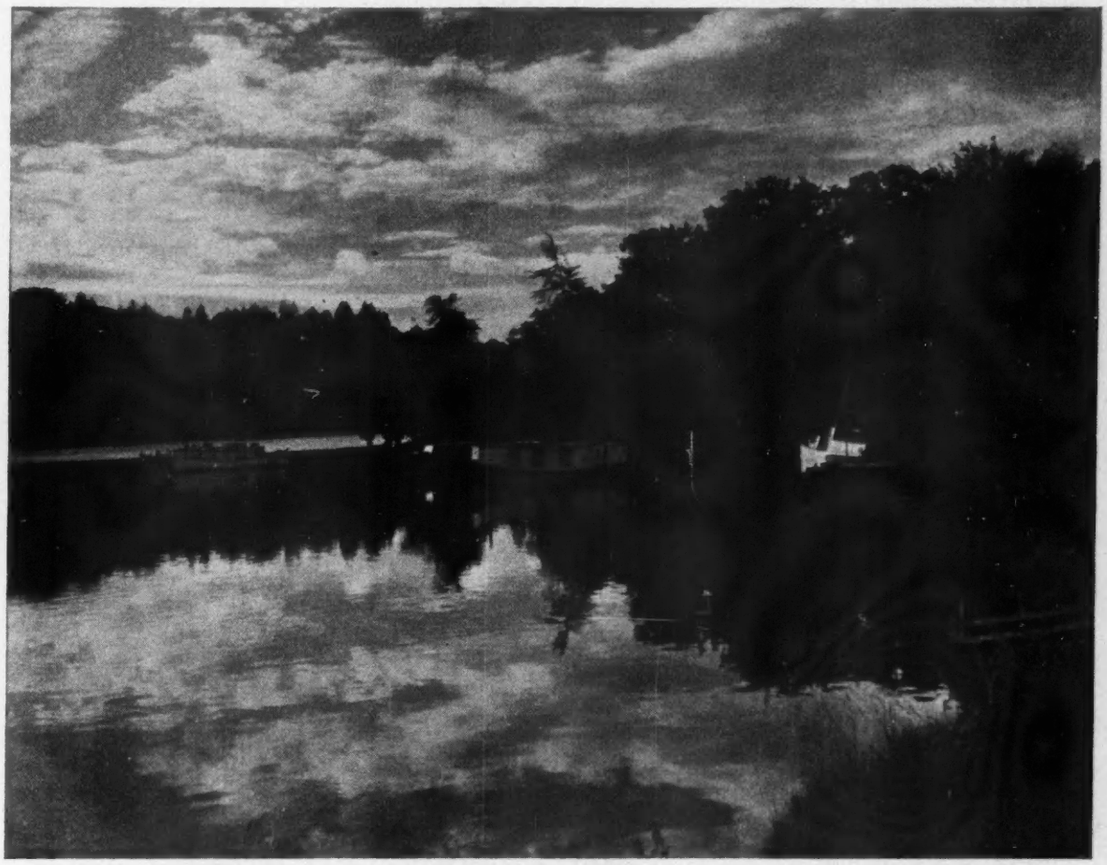

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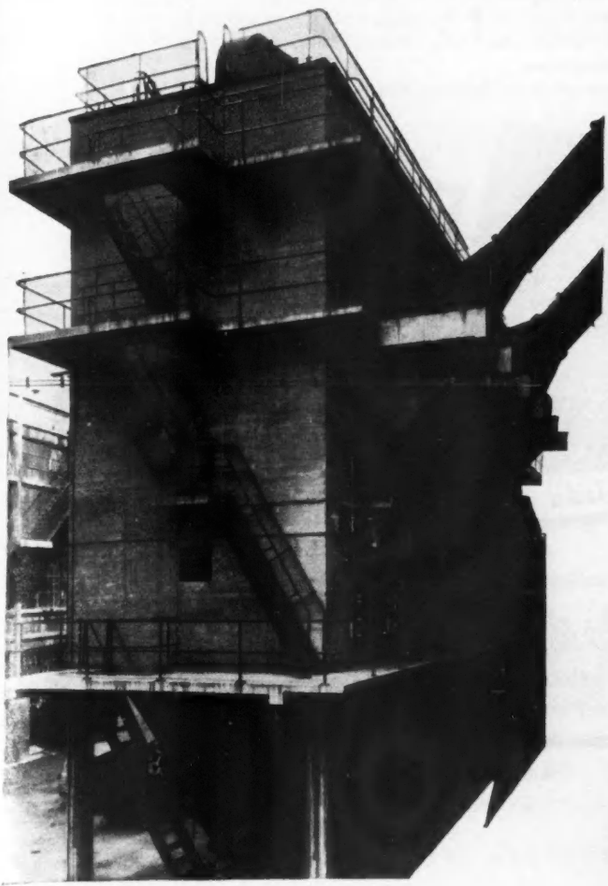

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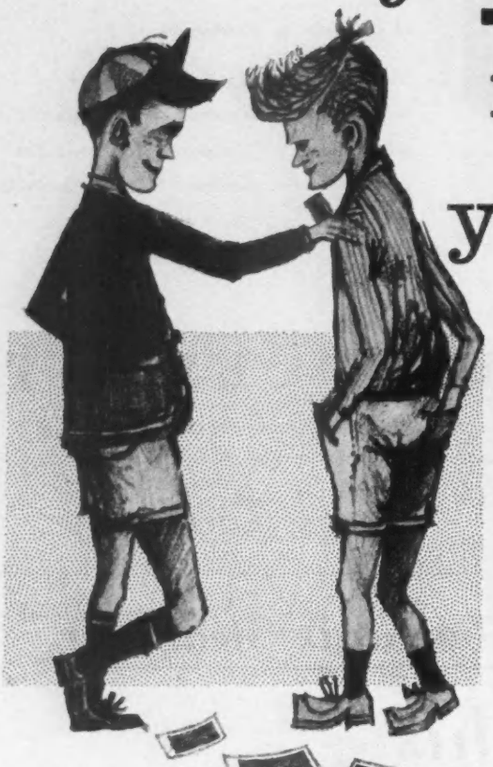

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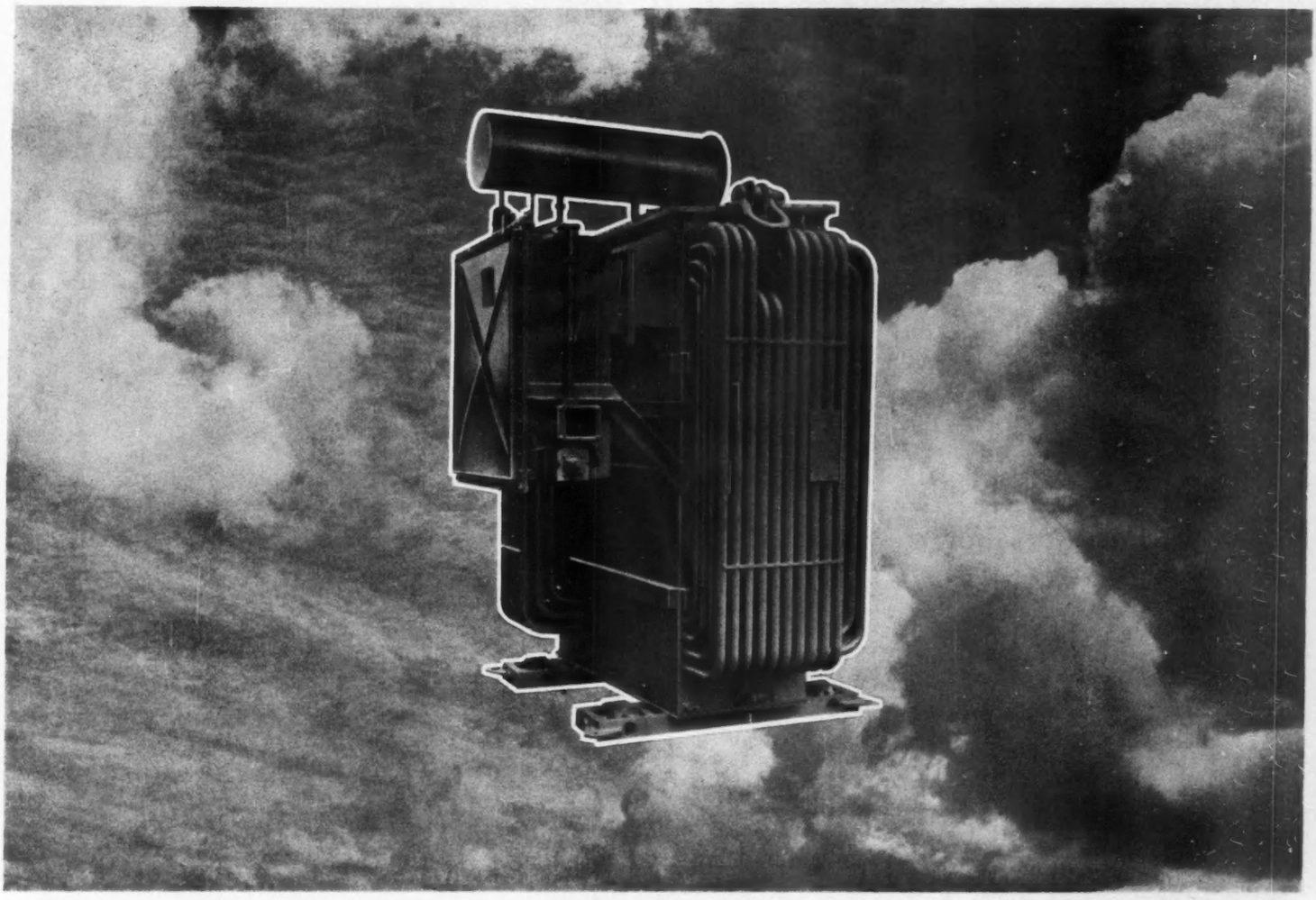

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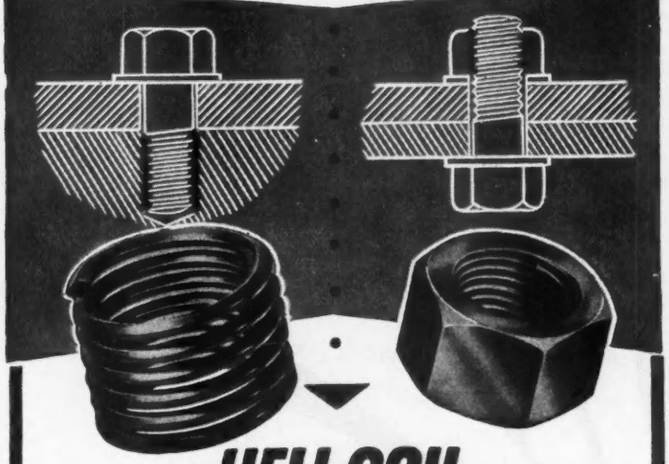

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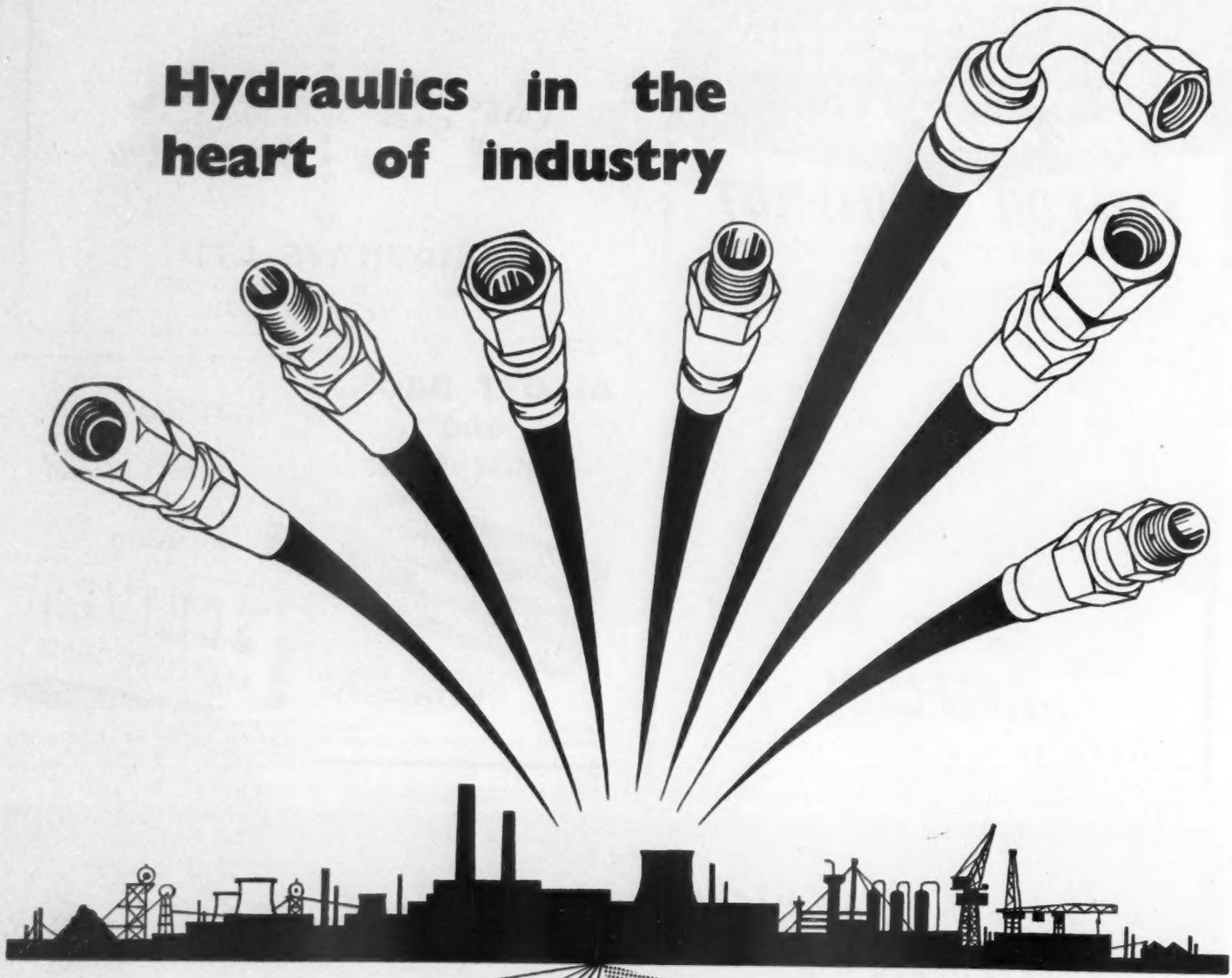

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The illustration shows a 1" eccentric-type self-adjusting joint. This forms the crank-pin and big-end bearing of a crank operating the cutter bar of a mower, at many hundreds of strokes a minute.

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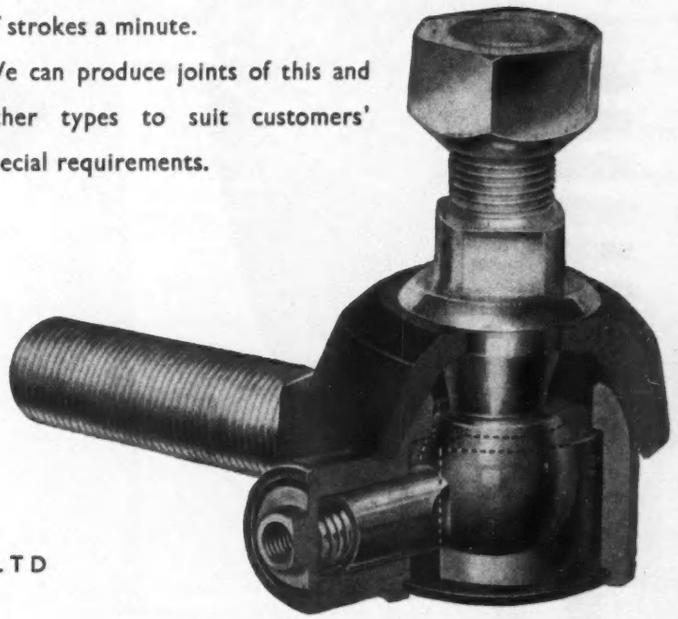
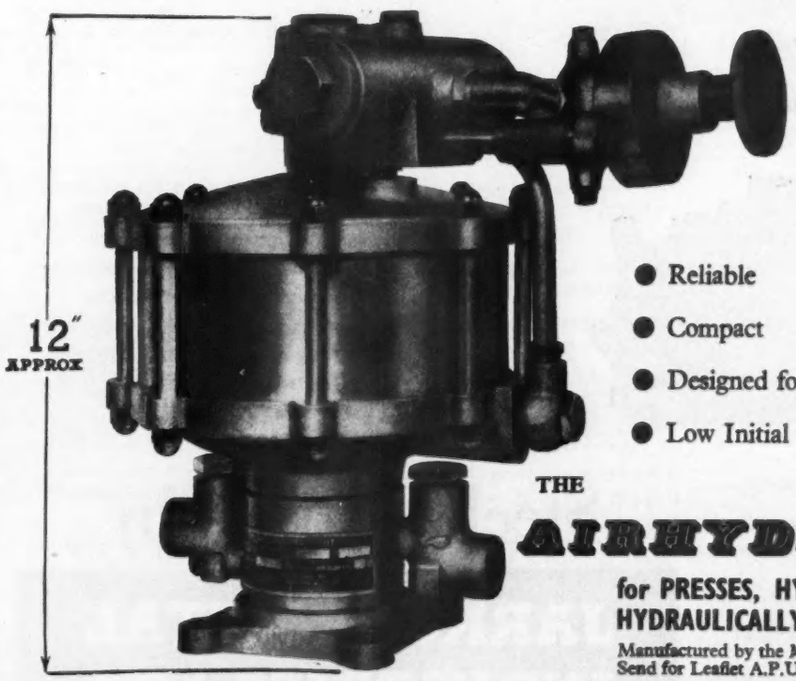


AUTOMOTIVE PRODUCTS COMPANY LTD
LEAMINGTON SPA, WARWICKSHIRE

It's New! HYDRAULIC POWER



9 Models Give Pressure Range from **62-22,500** p.s.i.

Operated by Compressed Air from **5-100** p.s.i.

Weights from 50-81 lbs.

- Reliable
- Compact
- Designed for High Output
- Low Initial Cost
- Negligible Maintenance
- Non-Corrosive
- No Consumption of Air when maintaining Static Pressure

THE

AIRHYDRO POWER UNIT

for PRESSES, HYDRAULIC JACKS, HYDRAULICALLY LOADED ROLLS, etc.

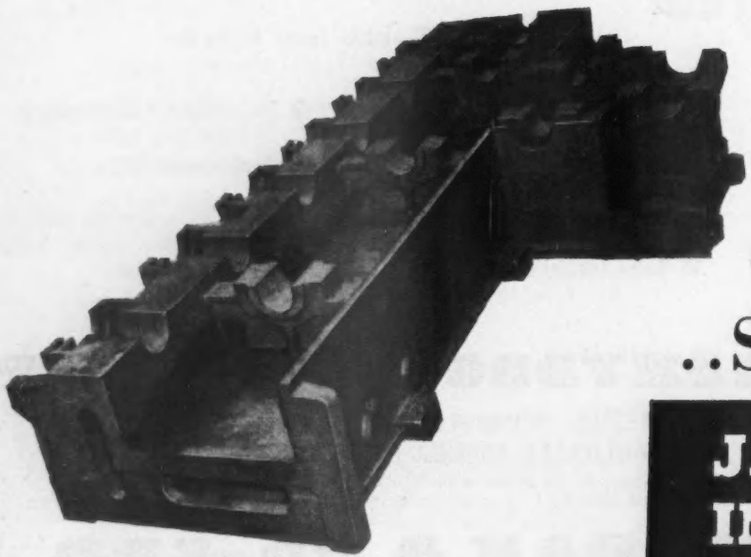
Manufactured by the Makers of the World Famous 'AIRHYDROPUMP'
Send for Leaflet A.P.U. 1 complete with Output Graphs

CHARLES S. MADAN & CO. LTD.

Vortex Works Atlantic Street Altrincham Cheshire
Telephone Altrincham 2702 (3 lines)

206

Whatever the shape or size....



DRIVESIDE FRAME AND GEAR BOX 207/252
Weight: 12 tons, 19 cwts.
Dimensions: 17' 6" × 8' 6" × 4' 3"

We have produced an astonishing variety of Castings in our time, large, small and intricate. We cover all ranges of plain carbon and alloy compositions, including steels to British Standard and Special specifications. This includes Molybdenum non-creep steels, chromium steels for wear resisting castings and low nickel chrome and high alloy steels. The austenitic heat and corrosion resisting range is also available.

..Steel Castings by

JARROW METAL INDUSTRIES LTD

Western Road, Jarrow-on-Tyne

In association with Armstrong Whitworth (Metal Industries) Ltd., Close Works, Gateshead, 8, Co. Durham

CLASSIFIED ADVERTISEMENTS

AGENCIES · DIRECTORS · PARTNERSHIPS · SITUATIONS VACANT · EDUCATIONAL PATENTS · BUSINESS OPPORTUNITIES · MISCELLANEOUS · PUBLIC APPOINTMENTS BUSINESSES and PREMISES · TENDERS

Lineage Rate. 4/- per line of approximately 6 words. Minimum 16/-.

Inch Rate. 48/- per single column inch and *pro rata*. 12 lines to 1 inch. There are reduced rates (*i.e.*, not on a *pro rata* basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £25 10s. ½-page £48. Full page £90.

AUCTION SALES · FOR HIRE · MACHINERY, etc., WANTED · SITUATIONS WANTED DRAWING AND DESIGN SERVICES · FOR SALE · SUB-CONTRACTING

Lineage Rate. 3/6 per line of approximately 6 words. Minimum 14/-.

Inch Rate. 42/- per single column inch and *pro rata*. 12 lines to 1 inch. There are reduced rates (*i.e.*, not on a *pro rata* basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £22. ½-page £41 10s. Full page £78.

Series Discounts. For advertisements 1 inch and upwards. 6 insertions 5%. 13 insertions 10%. 26 insertions 15%.

Run-On and Semi-Displayed Styles. Both these styles are available for single column width advertisements of any depth up to 12 inches.

Displayed and Illustrated Styles. The minimum size for a Displayed advertisement is 3 inches single column, for an illustrated advertisement it is a ¼-page (12 column inches). Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

Use of Box Number. 2/- which includes forwarding of replies.

Copy Dates. "Run-on" and "Semi-displayed" advertisements by noon Tuesday for publication on Friday same week. "Displayed" and "Illustrated" advertisements by noon Friday for publication on following Friday. All advertisements three days earlier if proofs are required.

Advertisements for publication should be addressed to:—**Classified Advertisement Dept., "The Engineer" 28 Essex Street, Strand, London, W.C.2.**

Urgent advertisements may be telephoned to CENtral 6565.

PUBLIC APPOINTMENTS

LONDON COUNTY COUNCIL

DAY COLLEGES
(WITH EVENING DEPARTMENTS)

APPOINTMENTS

Applications invited for the following posts for work with full and part-time day release and evening students. Work is mainly to G.C.E. (O level) and first-year O.N.C. Burnham F.E. salary scales :

Grade B Assistant £650 by £25 to £1025 (man), £620–£1025 (woman).

Grade A Assistant £475 by £25 to £900 (man), £455 14s.–£900 (woman).

Plus £36 or £48 London allowance, additions for qualifications and training ; increments within scale for experience. Forms and further details from Principals at Colleges to be returned by 20th June.

BRIXTON DAY COLLEGE, 56, Brixton Hill, S.W.2.

(I) GRADE B ASSISTANT plus £100 allowance to teach General subjects and to be responsible for the organisation and development of general education courses throughout the College.

(II) GRADE A ASSISTANT for ELEMENTARY SCIENCE for Technical Course Students.

WOOLWICH DAY COLLEGE, Vicarage Road, S.E.18.

GRADE B ASSISTANT plus £100 allowance for Mathematics and Science throughout the College. Should be graduate or hold H.N.C. in Electrical Engineering (1063). E7361

BEDFORDSHIRE EDUCATION COMMITTEE

THE MANDER COLLEGE BEDFORD

LECTURER

Applications are invited for appointment as LECTURER IN MECHANICAL ENGINEERING as from 1st September, 1958. Candidates should be Graduates with industrial experience, qualified to teach Applied Thermodynamics and Fluid Mechanics to H.N.C. standard.

Salary scale : £1200 by £30 to £1350. Increments may be added, up to the maximum, for approved industrial experience.

Forms of application and further particulars obtainable from the College Principal.

T. S. LUCKING,
Director of Education.
E7291

UNIVERSITY OF NOTTINGHAM

DEPARTMENT OF MECHANICAL ENGINEERING

LECTURER

Applications are invited fror the appointment of ASSISTANT LECTURER or LECTURER in Mechanical Engineering. Candidates should have a good Honours Degree in Engineering and research and/or subsequent industrial experience. Salary scales—Lecturer £900 to £1650 ; Assistant Lecturer £700 to £850, initial salary according to qualifications and experience. Membership of Universities Superannuation Scheme and family allowances. Conditions of appointment and form of application, which should be returned by 30th June, 1958, from the Registrar. E7356

BUCKINGHAMSHIRE EDUCATION COMMITTEE

THE RADCLIFFE SCHOOL, WOLVERTON

METALWORK MASTER

A new grammar-technical school for 720 boys and girls will be formed in September, 1958, by the amalgamation of the existing Grammar and Technical Schools at Wolverton. A new building will be started shortly. Applications are invited from qualified men for the post of METALWORK MASTER to teach this subject to "O" level G.C.E. Technical drawing an advantage. Industrial experience desirable. Salary scale £475–£900, according to qualifications and experience.

Further details and application forms (stamped, addressed envelope) from the Headmaster Elect, Mr. D. E. Morgan, M.A. E7340

CARMARTHENSHIRE EDUCATION COMMITTEE

AMMANFORD TECHNICAL COLLEGE

ASSISTANT MASTER

Applications are invited for the post of Full-time ASSISTANT MASTER in Engineering Subjects (Mechanical and Electrical) at the above-named College.

Candidates should be Graduates in Engineering or possess qualifications of an equivalent standard and have had suitable industrial experience (preferably mining) and teaching experience.

Salary in accordance with the Burnham Further Education Report for Grade B Assistants (£650 by £25 to £1025), with additions for Degree, approved training and previous experience.

Duties to commence on 1st September, 1958.

Forms of application, which must be returned not later than 14th June, 1958, may be obtained from the undersigned on receipt of a stamped addressed envelope.

IORWERTH HOWELLS,
Direction of Education.
Education Department,
County Hall,
Carmarthen. E7345

COUNTY BOROUGH OF EAST HAM

EAST HAM TECHNICAL COLLEGE

ASSISTANT GRADE "B"

Applications are invited for the undermentioned posts in the Department of Engineering :—

(a) ASSISTANT, Grade "B," to teach Machine Shop Engineering and ancillary subjects, e.g. Calculations and Science in the City and Guilds Machine Shop Engineering and Mechanical Craft Practice Courses.

(b) ASSISTANT, Grade "B," to teach Mathematics in the National Certificate and City and Guilds Courses, initially to S.2 Ordinary National Certificate level.

BURNHAM SALARY SCALE : £650 by £25 to £1025, plus London Allowance £36 or £48 and appropriate allowances for Degree, training and industrial experience.

Forms of application (returnable by 20th June, 1958) and further particulars, from the Chief Education Officer, Town Hall Annexe, Barking Road, London, E.6. E7365

WILTSHIRE EDUCATION COMMITTEE

SALISBURY AND SOUTH WILTSHIRE COLLEGE OF FURTHER EDUCATION

ASSISTANT GRADE "B" IN ELECTRICAL ENGINEERING

Appointment of ASSISTANT GRADE "B" (possibly Lecturer in 1959) to teach Electrical Engineering at S.3 level and Electrotechnology with Electronics to Advanced level. Applicants should be prepared to undertake the responsibility for further developing of a H.N.C. course which was started in September, 1957.

Required in September, 1958, or as soon after as possible.

Further details from the Principal, College of Further Education, Churchfields, Salisbury.
27th May, 1958. E7343

UNIVERSITY OF NOTTINGHAM

DEPARTMENT OF MECHANICAL ENGINEERING

SENIOR RESEARCH ASSISTANT

Honours graduates in Engineering or Physics are invited to apply for appointment as SENIOR RESEARCH ASSISTANT in the above Department. Salary within the scale £900 to £1300, with membership of the Universities Superannuation Scheme and family allowances. Conditions of appointment and form of application which should be returned by 30th June, 1958, from the Registrar. E7354

NOTTINGHAM AND DISTRICT TECHNICAL COLLEGE

SHAKESPEARE STREET, NOTTINGHAM

Principal : D. A. R. CLARK, M.Sc. (Tech.), M.I.Mech.E.

LECTURERS

Due to an increase in the volume of advanced work, the following additional appointments to the full-time teaching staff are required for September next. The College will, in the main, concentrate in the future on post-Ordinary National Certificate and post-Intermediate City and Guilds work. A large new building costing approximately one million pounds will come into full use in September next and will provide accommodation for well-equipped Departments of Building and Civil Engineering, Electrical Engineering, Chemistry, Physics and Mathematics, and Mining. Increased accommodation is also available to the Departments of Mechanical Engineering, Arts and Commerce, Printing and Textiles. Research work by both staff and students is being rapidly developed. College senior teaching staff will be expected to undertake or supervise research work. Consultancy work by staff is encouraged.

Industrial, teaching and research experience will all be of considerable advantage to the selected candidate.

SENIOR LECTURER IN THEORY AND DESIGN OF MACHINES, with particular reference to Control Engineering.

LECTURER IN THERMODYNAMICS.

LECTURER IN CIVIL ENGINEERING.

Salaries in accordance with the Burnham Technical Scale, as follows : Senior Lecturer : £1350, rising by annual increments of £50 to £1550 per annum. Lecturer : £1200, rising by annual increments of £30 to £1350 per annum.

Further particulars and form of application may be obtained from the Principal, to whom completed forms should be returned not later than 20th June, 1958. E7366

CITY OF LEICESTER EDUCATION COMMITTEE

COLLEGE OF TECHNOLOGY AND COMMERCE

ASSISTANT LECTURER

ASSISTANT LECTURER (Grade B) required in the School of Engineering, from September, 1958, to teach Applied Mechanics, Thermodynamics and Engineering Drawing in Ordinary National Certificate courses. Some City and Guilds of London Institute and Higher National work may also be required.

Salary : Burnham Technical Scale, £650 by £25 to £1025 per annum, with Degree and training allowance and increments for approved teaching and/or industrial experience and War Service.

Forms of application and further particulars can be obtained from the Registrar, College of Technology and Commerce, Leicester, to whom the completed forms should be returned as soon as possible. E7386

NORTH RIDING EDUCATION COMMITTEE

CLEVELAND TECHNICAL COLLEGE, REDCAR

ASSISTANTS

Applications are invited for the following posts to take effect from 1st September, 1958.

1. ASSISTANT (GRADE B) for Mechanical Engineering to O.N.C.
2. ASSISTANT (GRADE A) for Machine Shop Practice.
3. ASSISTANT (GRADE A) for Motor Vehicle/Agricultural Machinery Subjects.
4. ASSISTANT (GRADE A) for Sheet Metal Work/Welding.

Forms and particulars available from me on receipt of stamped addressed envelope. Completed forms to be returned by 17th June, 1958.

F. BARRACLOUGH.
County Hall,
Northallerton. E7395

UNIVERSITY OF NOTTINGHAM

DEPARTMENT OF MECHANICAL ENGINEERING

RESEARCH ASSISTANT

RESEARCH ASSISTANT required to develop a new technique of Experimental Stress Analysis. Candidates should be Engineers or Physicists with University Degree, Higher National Certificate or equivalent qualifications. Initial salary £700 to £800, according to qualifications and experience. Conditions of appointment and form of application, which should be returned by 30th June, 1958, from the Registrar. E7355

WARRINGTON EDUCATION COMMITTEE

TECHNICAL COLLEGE

ASSISTANT, GRADE A, IN MECHANICAL ENGINEERING

ASSISTANT, Grade A, IN MECHANICAL ENGINEERING required for 1st September, 1958, mainly to teach subjects in the National Certificate Courses.

Application forms and further particulars may be obtained from the Chief Education Officer, Education Office, Sankey Street, Warrington, upon receipt of a stamped, addressed foolscap envelope, and should be returned as soon as possible. E7336

WESTERN REGIONAL HOSPITAL BOARD

SCOTLAND

ASSISTANT ENGINEER (ELECTRICAL)

Applications are invited for the post of ASSISTANT ENGINEER (ELECTRICAL). Applicants should be Corporate Members of, or have obtained the technical standard of, Corporate Membership of the Institution of Electrical Engineers, and should have practical and theoretical experience of design, installation and operation and general maintenance, and should be capable of assisting in preparing specifications and estimates and advising generally on electrical installations, including heating, lighting and power.

Salary scale, £700 by £25 (3) by £30 (1) by £35(1) to £1015.

Starting salary may be above the minimum having regard to experience. The successful applicant will be required to pass a medical examination and the appointment is subject to a deduction at the rate of 6 per cent. for superannuation.

Applications, giving particulars of qualifications and experience, together with the names of three referees, should be lodged with the Secretary, Western Regional Hospital Board, 64, West Regent Street, Glasgow, C.2, not later than 14th June. E7348

ADMIRALTY

ROYAL NAVAL SCIENTIFIC SERVICE

DRAUGHTSMEN

DRAUGHTSMEN required in Admiralty Research and Development Establishments in London (Teddington area), Portsmouth, Weymouth and Baldock (Herts), for the design of experimental apparatus needed for fundamental research or for fitting in H.M. Ships. Experience is necessary in any of the following classes of equipment : light to medium electrical, electro-mechanical, precision mechanical and electronic.

Candidates must be British, aged 21 years or over, with at least three years' practical workshop training and, preferably, with drawing-office experience and possession of the O.N.C. or equivalent.

Appointments unestablished but opportunities will occur to compete for established posts and for promotion.

Starting pay (London) £550 (age 21) ; £755 (age 28) ; scale maximum £870 ; slightly less in the provinces.

Apply, stating age, training, experience and qualifications, to Admiralty, Queen Anne's Mansions (Room 809), St. James's Park, London, S.W.1. E7052

Classified Advts. continued on page 128

PUBLIC APPOINTMENTS

TRINIDAD AND TOBAGO ELECTRICITY COMMISSION

SUPERINTENDENT—GENERATION DIVISION

Applications are invited for the post of SUPERINTENDENT—GENERATION DIVISION based on Port of Spain, at an annual salary of £2500. Applicants must have a degree in engineering and/or be a Corporate Member of the I.E.E., or I.Mech.E. They must have had experience in the control, operation, maintenance and construction of thermal and diesel power stations and experience in general administration. The Superintendent—Generation Division will be responsible to the General Manager for the operation and efficiency of the Commission's two Power Stations which have a total installed capacity of 62MW. Extensions are in progress for an additional 20MW generating plant and further extensions are contemplated.

HOUSING : A partly furnished house will be provided at a rental of £10 8s. 4d. a month plus a small extra charge for heavy furniture.

LEAVE : 45 days annual leave is granted each year. Fourteen days of this must be taken locally and the balance can be accumulated for overseas leave in the third year.

PASSAGES : First class passages will be provided for the successful applicant, his wife and children up to the age of 18 up to a maximum cost of two adult passages.

OUTFIT ALLOWANCE : A £60 outfit allowance will be paid on arrival in Trinidad.

CAR ALLOWANCE : A car allowance for necessary mileage is paid and an interest-free loan advanced for the purchase of a car.

General information on Trinidad, climate, Income Tax, etc., can be obtained from the West Indian Committee, 40, Norfolk Street, London, W.C.2.

Applications giving full details of qualifications, age and experience together with two recent testimonials, should reach the General Manager, Trinidad and Tobago Electricity Commission, P.O. Box 121, Port of Spain, Trinidad, B.W.I. before the 30th June, 1958. E7334

NATIONAL COAL BOARD

NORTHERN (N. AND C.) DIVISION, NO. 3 AREA

AREA CENTRAL WORKSHOPS STAFF

Staff are required as follows for a new Central Workshops at Ashington, Northumberland :—

WORKSHOPS SUPERINTENDENT, £900 to £1400 p.a.

CHIEF PLANNER, £750 to £1150 p.a., or £900 to £1400 p.a.

SENIOR PLANNER, £750 to £1150 p.a.

CHIEF INSPECTOR, £750 to £1150 p.a., or £900 to £1400 p.a.

SENIOR INSPECTOR, £600 by £25 to £900 p.a.

The Workshops Superintendent will assist the Workshops Manager in the supervision of engineering work. The other staff will be responsible for the implementation and operation of planning, progressing and inspection systems on the overhaul of colliery plant and equipment.

Engineering qualifications are required—at least H.N.C.—and workshops experience would be an advantage. Salaries will be within ranges stated in accordance with qualifications and experience.

Applications, giving date of birth and full details of education and experience, to Area Staff Manager, National Coal Board, Northern (N. and C.) Division, No. 3 Area, Mining Offices, Ashington, Northumberland, by 20th June, 1958. Please state for which post applying and quote CW/4. E7350

GOVERNMENT OF BAHRAIN

BAHRAIN STATE ELECTRICITY DEPARTMENT

SHIFT CHARGE ENGINEERS

SHIFT CHARGE ENGINEERS required for a new power station comprising 4—1000kW dual fuel engine-driven alternators and 3—6100kW Brown Boveri gas turbo alternators, the latter plant now in course of erection with the first unit to be commissioned for Summer, 1958.

Preference will be given to candidates between 30–45 years of age with qualifications equivalent to H.N.C., B.O.T. (Steam and Diesel) or C.E.R.A., who have had operating experience on similar generating plant for at least 5 years.

Consolidated salary equivalent to £1550 per annum. There is also a Pension Fund.

Free furnished bachelor quarters and medical attention provided. Married accommodation provided after satisfactory completion of six months' probationary period. Contract in the first place for a period of two years subject to six months' probation. Leave is granted at the rate of ten weeks per annum and free passages by air to and from London are provided for the successful candidate and his wife every two years.

Applications in the first instance giving full details of qualifications, training and experience to be addressed to the Personnel Officer, EWBANK AND PARTNERS, LIMITED, 10–11, Grosvenor Place, London, S.W.1. E7369

CITY OF BIRMINGHAM WATER DEPARTMENT

NEW WORKS AND CONTRACTS

ASSISTANT ENGINEER

Applications are invited for the above appointment ; salary range £595–£1030 per annum, according to qualifications and experience. Post pensionable—medical examination. Canvassing disqualifies.

Application forms and further particulars from General Manager and Secretary, Water Department, Council House, Birmingham, 3, returnable by 16th June, 1958. E7342

PUBLIC APPOINTMENTS

GOVERNMENT OF QATAR (PERSIAN GULF)

ASSISTANT DISTRIBUTION ENGINEER

Applications are invited for the appointment of an ASSISTANT DISTRIBUTION ENGINEER to assist the Distribution Engineer in the planning, construction and maintenance of H.T. and L.T. networks overhead and underground, substations, switchgear, etc., the supply voltage being 11kV and 3·3kV H.T. and 415/240 volts L.T.

Candidates must be in possession of at least a Higher National Certificate in Electrical Engineering and preference will be given to those who hold an engineering degree or are Corporate Members of the Institution of Electrical Engineers. They should also preferably have had at least 10 years' experience with an electricity supply undertaking.

TERMS AND CONDITIONS OF SERVICE

Probationary period of six months during which the contract may be terminated at three months' notice by the Government.

Contract for five years subject to successful completion of probationary period. The employee may terminate the contract by giving three months' notice in writing after completing one year's service.

The salary scale is from Rs.1775 per month rising by annual increments of Rs.75 to Rs.2000 per month and then by increments of Rs.100 to a maximum of Rs.2300 per month. The point of entry into the scale will be in accordance with the candidates qualifications and experience.

A gratuity amounting to one month's salary for each completed year of service is payable on completion of contract only.

Free furnished bachelor accommodation, fuel, light and water. Married accommodation will be provided if desired as soon as it becomes available provided, however, that the Government retains the right to recover the cost of any passages for wife and family if the appointment is terminated within the probationary period.

Leave is earned at the rate of six days per completed month of duty and may be taken annually.

Free air or sea passages, on first appointment, on leave and on final termination of contract, are provided for applicant, wife and children up to 18 years of age.

An initial loan for the purchase of a car and running allowance are granted which fully cover the cost of running and depreciation.

Medical and dental treatment for the employee and his family are provided free.

A knowledge of Arabic would be an advantage and in any case the employee will be expected to apply himself to a diligent study of colloquial Arabic and to reach the standard of efficiency required by the Government regulations.

All calculations of pay and leave according to the Arabic calendar in force in Qatar.

Applications endorsed "Assistant Distribution Engineer, Qatar," accompanied by full personal particulars including age, education, qualifications, experience, religion and past employment should be made in writing within 14 days of the date of this advertisement to Preece, Cardew and Rider, 8, 10 and 12, Queen Anne's Gate, Westminster, London, S.W.1. E7333

DUNMOW RURAL DISTRICT COUNCIL

APPOINTMENT OF ASSISTANT RESIDENT ENGINEER

Applications are invited for the above appointment on the staff of the Resident Engineer for the construction of sewerage and sewage disposal works under the direction of the Consulting Engineers, J. D. and D. M. Watson, MM.I.C.E., 18, Queen Anne's Gate, Westminster, S.W.1. Applicants should be suitably qualified and preferably have some knowledge of sewerage and sewage disposal design.

The salary offered will be between £600 and £800 per annum, according to qualifications and experience. The appointment will be subject to one month's notice on either side and, subject to satisfactory service, is expected to last at least a year. Some travelling is likely to be necessary and if the person appointed uses his own car on duty the Council will pay a travelling allowance at a rate not exceeding that payable for a 10 H.P. or 1199 c.c. vehicle in accordance with the National Scheme of Conditions of Service.

Applicants should apply by June 30th, 1958, in writing, to the undersigned, giving full particulars of age, qualifications and experience, and enclose copies of not less than two testimonials or the names of two referees.

A. H. BURTON,
Clerk of the Council.

Council Offices,
Dunmow,
Essex. E7387

CIVIL SERVICE COMMISSION

ADMIRALTY

METHOD STUDY ENGINEER

Pensionable post in London for man normally at least 30 on 1st June, 1958, to organise and supervise Work Study and Industrial Management Training in Air Repair Organisation and advise on application of Work Study. Applicants must have achieved Corporate Membership of a major Engineering Institution and have experience in management, including the application of Work Study. Salary : £1280–£1720.

Write, Civil Service Commission, 30, Old Burlington Street, London, W.1, for application form, quoting S4847/58. Closing date, 24th June, 1958. E7339

PUBLIC APPOINTMENTS

NATIONAL COAL BOARD

NORTH STAFFS AREA

CIVIL ENGINEERING ASSISTANTS

Two CIVIL ENGINEERING ASSISTANTS are required by the North Staffs Area of the West Midlands Divisional Coal Board. NS(58)79/1

Applicants should be Corporate Members of the Institution of Civil Engineers or the Institution of Structural Engineers, or possess exempting qualifications from the examinations of those Institutions. A good knowledge of reinforced concrete and structural steelwork design is desirable, together with experience in the design of road construction, foundations, drainage schemes and layout of railway sidings. A knowledge of specifications, bills of quantities and contract conditions would be of advantage. NS(58)79/2

Applicants should be Corporate Members of the Institution of Municipal Engineers, and have had experience in land drainage, sewers, pipe lines, and be accustomed in the preparation of schemes for the treatment of colliery effluents.

Both posts attract a salary, according to experience and qualifications, in the range £900–£1400 per annum.

Forms of application, obtainable from the Area Staff Manager, National Coal Board, 72, Leek Road, Stoke-on-Trent, should be returned not later than 16th June, 1958, quoting the appropriate reference number. E7374

CENTRAL ELECTRICITY GENERATING BOARD

CIVIL ENGINEERING BRANCH

ASSISTANT QUANTITY SURVEYOR

Central Electricity Generating Board require an ASSISTANT QUANTITY SURVEYOR in the Civil Engineering Branch at Headquarters, Bankside House, Sumner Street, London, S.E.1.

The successful candidate will carry out general quantity surveying duties, but in particular may be required for the remeasurement and valuation of large-scale variations on civil engineering and building works in connection with nuclear power stations. Candidates will be expected to have a sound knowledge of both the civil engineering and building methods of measurement, analysis of prices, agreement of rates, and assessment of claims ; and should have experience of the settlement of final accounts for large industrial building and civil engineering works. Candidates should have qualifications equivalent to Associate of the Royal Institution of Chartered Surveyors or the Institute of Quantity Surveyors. Salary within £1210–£1570 p.a., according to qualifications and experience.

Application forms obtainable from S. S. Scott, Chief Personnel Officer, 24/30, Holborn, London, E.C.1, to be returned by 17th June. Envelopes should be marked "Confidential," quoting reference ENR/144. E7349

THE ROYAL COLLEGE OF SCIENCE AND TECHNOLOGY GLASGOW

(In affiliation with the University of Glasgow)

DEPARTMENT OF MECHANICAL, CIVIL AND CHEMICAL ENGINEERING

LECTURER IN ENGINEERING DRAWING

Applications are invited from candidates who have good technical qualifications and wide experience of modern drawing-office practice. The vacancy would suit a Senior Draughtsman. Salary on scale £900 by £50 to £1350 by £75 to £1650, with superannuation and family allowances.

Forms of application from the Secretary, Royal College of Science and Technology, Glasgow, C.1.

E7377

THE ROYAL COLLEGE OF SCIENCE AND TECHNOLOGY GLASGOW

DEPARTMENT OF MECHANICAL, CIVIL AND CHEMICAL ENGINEERING

ASSISTANT LECTURERS

Applications are invited for Assistant Lecturers in Mechanical and Civil Engineering. Candidates should have a good Honours Degree and some industrial experience. Excellent facilities exist for post-graduate work, leading to the Degree of Ph.D.

Salary scale £700–£850 per annum, with placement according to experience and qualifications, and with F.S.S.U. and family allowances.

Forms of application may be obtained from the Secretary of the College.

E7376

PUBLIC APPOINTMENTS

SENIOR RESEARCH METALLURGIST—WELDING

$9060—$10,140.

Department of Mines and Technical Surveys, Ottawa, Ontario, Canada.

TO

—Initiate and supervise fundamental and applied research in welding, brazing and soldering of new and existing ferrous, non-ferrous alloys.

—Advise Canadian Government Departments and Industry on design of equipment.

—Prepare technical reports and deliver technical addresses.

Extensive related experience is required. Please write comprehensive résumé of academic qualifications and experience in first instance to :

Civil Service Commission,
Ottawa, Ontario, Canada.
Quote 58–1501. E7274

THE ROYAL COLLEGE OF SCIENCE AND TECHNOLOGY GLASGOW

DEPARTMENT OF MECHANICAL, CIVIL AND CHEMICAL ENGINEERING

LECTURERS IN MECHANICAL ENGINEERING

Applicants should have a good Honours Degree and industrial experience in some branch of Mechanical Engineering. Courses are conducted on a sandwich system which leaves the summer term free for research, opportunities for which are exceptionally good. Members of staff are encouraged to carry out research leading to Higher Degrees.

Salary on scale £900 by £50 to £1350 by £75 to £1650, with F.S.S.U. and family allowances.

Form of application may be obtained from the Secretary of the College.

E7375

TENDERS

INDIA STORE DEPARTMENT

SHEET STRAIGHTENING MACHINE

The Director General, India Store Department, Government Building, Bromyard Avenue, Acton, London, W.3 invites TENDERS for the SUPPLY of :—

18023/1/GNK/HAL

SHEET STRAIGHTENING MACHINE—Motor Driven—17 rolls—from 1mm to 3·5mm thickness.

The Tender forms with schedules and specifications which are returnable on Thursday, the 3rd July, 1958, may be obtained from the above office (C.D.N. Branch) on payment of a fee (which is not refundable) of ten shillings for each Tender. Applications for Tenders should clearly state the reference number of the tenders required. E7353

EDUCATIONAL

UNIVERSITY OF EDINBURGH

POST-GRADUATE SCHOOL OF APPLIED DYNAMICS

A Post-graduate Course, leading to the Diploma in Applied Dynamics, will be given in the Department of Engineering from October, 1958, until June, 1959. The Course will provide specialised training for graduates who are working, or who intend to work, on dynamical problems. Applicants should hold an Honours Degree in Engineering, Mathematics or Physics.

The main Lecture Courses will be in dynamics of solids, analytical methods, mechanical vibration, gyrodynamics, and theory of control systems. Laboratory work in the field of applied dynamics will also be undertaken.

A limited number of grants may be awarded to suitable candidates.

Further particulars and forms of application may be obtained from the Faculty of Science Office, Chemistry Department, University of Edinburgh, West Mains Road, Edinburgh, 9.

CHARLES H. STEWART,
Secretary to the University.

May, 1958. E7172 x

UNIVERSITY OF LONDON KING'S COLLEGE invites applications for the LEVERHULME STUDENTSHIP IN CHEMICAL ENGINEERING, value £500 a year for one or two years, from 1st October, 1958. Applicants must have a post-graduate diploma in Chemical Engineering or equivalent qualifications.—Forms from the Registrar, King's College, Strand, W.C.2, whom completed applications must reach by June 30th. E7383 x

EDUCATIONAL

A.M.I.MECH.E., B.Sc., City and Guilds, &c. Guarantee Postal Courses for all Exams., and Technical Divisions from Elementary to Degree standard. Approximately 95 per cent. successes. 144-page prospectus free on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E114 E

FREE! Brochure giving details of Courses in Mechanical and Production Engineering, Draughtsmanship, &c., for the A.M.I.Mech.E., A.M.I.P.E., City and Guilds and other professional examinations. —E.M.I. Institutes, Dept. E.30, London, W.4. (Associated with H.M.V.) E117 E

UNIVERSITY OF LONDON KING'S COLLEGE offers a RESEARCH STUDENTSHIP, made available by Usines Emile Henricot, S.A., and tenable for one year with possible renewal for a second year. The value will be £500 per annum. The Studentship is for research into various aspects of the behaviour of ball mills. The character of the research is such that it should lead to a Higher Degree.

Applicants should have a good Honours Degree in Engineering.—Particulars and application forms from the Registrar, King's College, London, Strand, W.C.2, whom completed forms must reach by July 21st. E7384 E

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES, NOT ORIGINALS, OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

A LARGE INDUSTRIAL ORGANISATION has vacancies for qualified MECHANICAL ENGINEERS, aged 30–35, with good social and educational background, to train as specialists, finally to take charge of staffs in various industrial areas in this country.—Reply, stating full details of age, qualifications and experience, to BOX No. E7302, "The Engineer." A

AIR CONDITIONING AND REFRIGERATION SERVICE AND TEST ENGINEER required in London office of large air conditioning company, to supervise installation, regulation and testing all types air conditioning, cooling, treatment installations. Required to travel all parts of country and on occasion abroad. Pension scheme and bonus.—Write to BOX E177 LPE, Romano House, 399/401, Strand, London, W.C.2. E7388 A

C.I.C. ENGINEERING LIMITED require an experienced PRODUCTION ENGINEER to take charge of small production a workshop (20–30 men) engaged on specialised work, including manufacture of components for prototype machines and assemblies for the shoe and rubber trades. Age group 30–40. Appropriate salary.—Please apply in writing to the Personnel Department (MSM), C.I.C. Engineering, Ltd., Street, Somerset, marking your application "Private." E7379 A

CIVIL ENGINEERING INSPECTOR required by Consultants for work in Rhodesia. General Public Works experience with emphasis on mass concrete. Would have to go out "single" initially. Age if right experience up to 55.—Please state employers, nature of work, &c., to BOX No. E7381, "The Engineer." A

CONSTRUCTION ENGINEER required for service in India, must have experience in the planning and installation of factory services for large modern engineering factory. Experience in the installation and commissioning of medium to large precision machine tools is required and a knowledge of accounting procedures is essential as successful applicant will be required to be responsible for local accounts. Three-year contract in first instance with prospect renewal. Salary, including allowances, up to Rs.2700 per month, free quarters, medical attention, use of car, free passages for engineer and family and other benefits.—Apply, giving details of age, experience, family circumstances and when available, to Secretary, A.E.I. Overseas, Ltd., Crown House, Aldwych, London, W.C.2. E7293 A

DESIGN DRAUGHTSMAN FOR DIESEL TRACTION

Sulzer Bros. (London), Ltd., require a capable design draughtsman in connection with their important contracts for diesel locomotives under the British Railways modernisation plans.

Sound training in mechanical engineering, works apprenticeship and drawing office experience essential.

Apply stating age, salary required and full particulars of qualifications and experience to Chief Draughtsman, 31, Bedford Square, W.C.1. E1917 A

DRAUGHTSMAN required for Development work on special purpose machinery. Wide knowledge of mechanisms essential. Applicants should be aged 21/25 years and have O.N.C. 5-day week. Sick and pension fund.—Apply in writing to Personnel Officer, Osram Glass Works, East Lane, North Wembley. E124 A

DRAUGHTSMAN required for interesting work on building, wiring and underground cable schemes, and records. Candidates should preferably hold technical qualifications to O.N.C. standard.—Apply, giving details of experience and salary required, to British Oxygen Wimpey, Ltd. (M. and E.), Spadeadam Research Establishment, Nr. Gilsland, Cumberland. E7358 A

DRAUGHTSMAN/TECHNICAL ASSISTANT required by Consulting Engineers for work connected with Dredgers and similar vessels. Preference given to candidates with both hull and machinery experience. Minimum qualification, O.N.C., Naval Architectural or Mechanical Engineering.—Apply, Sir Bruce White, Wolfe Barry and Partners, 1, Lygon Place, London, S.W.1. (SLOane 3433.) E7359 A

ENGINEER (Mechanical). Applications are invited from Engineers, not over 35 years, who possess 1st Class M.O.T. Certificate (Steam). Willing to reside in or near London for duties in that area and to undertake three-monthly tours of inspections of boilers, pressure vessels, &c., in West Africa. Salary in accordance with age, previous experience, if any, plus expenses and allowances. Non-contributory pension scheme.—Apply in own handwriting to BOX No. E7380, "The Engineer." A

ENGINEERING OFFICE MANAGER

Applications are invited for the newly created position of Engineering Office Manager in a medium sized firm of Chemical Manufacturers in the Manchester Area. The Company has a record of rapid expansion which is expected to continue and in which the Engineering Department plays a major part both in new construction projects and maintenance.

The successful applicant will be responsible to the Works Engineer for the administrative work in the Department of which purchasing, stores administration and cost control are the main areas. He will be a senior member of the staff and will be expected to make an important contribution to the development of administrative procedures.

Essential qualifications include a good general education and specific experience of purchasing and stores control procedures in Engineering, preferably in the Chemical Industry. An imaginative approach, both in the handling of staff and administrative development, is essential. Added qualifications would be some formal education in Engineering or Accountancy, and experience of cost control systems. The preferred age range is 28 to 40 years.

A substantial salary will be offered and a contributory superannuation scheme is in operation.

Applications, giving full details, should be forwarded to the Technical Director, BOX No. E7305, "The Engineer." E7305 A

ESTIMATING ENGINEER for progressive position with prominent London firm of land and marine boiler engineers. Drawing office experience essential; workshop experience an advantage. Attractive salary commensurate with experience and qualifications.—Write fully, stating age, etc., to BOX No. E7332, "The Engineer." A

ESTIMATOR for all types of Civil Engineering works required. Good prospects and Pension Scheme available after probationary period. Salary, housing, etc., by arrangement.—Write in confidence stating age, qualifications and details of experience to the Managing Director, The Dredging & Construction Co., Ltd., 9, New Conduit Street, King's Lynn, Norfolk. E1922 A

JOHN HOWARD & CO., LTD.,

require the following staff for large Civil Engineering Contracts, initially for planning work, London office, and subsequently for sites in Northern England, Scotland, Persian Gulf and Rhodesia.

SENIOR ENGINEERS.—Age 30 to 35, experience in steel and concrete design and site supervision.

JUNIOR ENGINEERS.—Age 23 to 30, University Degree or equivalent.

DRAUGHTSMEN, experienced in Structural Steel work, reinforced concrete, Docks and Harbours, Heavy foundations.

Good salary and prospects.—Write full details, qualifications and experience, 13, Buckingham Gate, London, S.W.1. E7341 A

JOHN LAING AND SON, LIMITED, invite applications from ASSISTANT SITE ENGINEERS, with experience of setting out and general site engineering duties on a variety of important contracts in the British Isles. A Civil Engineering Degree or the equivalent is desirable, but not essential.

Those interested should write to: PERSONNEL MANAGER (Ref. A.S.E.1), JOHN LAING AND SON, LIMITED, LONDON, N.W.7. E7133 A

MANFIELD ENGINEERING DEVELOPMENT CO., LTD.

require the following personnel for employment in their office at Forest Hill:

Civil, Structural and R.C. Designers;
Heating and Ventilating Designers.

Highest salaries paid to first-class men preferably holding H.N.C.

Please write, giving fullest particulars of experience, etc., to the above Company at 14b, Devonshire Road, Forest Hill, S.E.23 E7394 A

EXPERIENCED DRAUGHTSMEN of O.N.C or H.N.C. standard required for interesting design work on process plant and machinery. A good technical background and knowledge of machine design is essential and applicants should be qualified to H.N.C. standard. Salaries are assessed in accordance with age, qualifications and experience, and will be reviewed annually. The salary at 25 for those with H.N.C. is £750 p.a. Contributory superannuation and widows' pension fund are in operation and there are excellent canteen, welfare and recreational facilities.

Applicants should apply in writing to Group Personnel Department, PILKINGTON BROTHERS LIMITED, Grove Street, St. Helens, enclosing a brief history of their career and details of their education and qualifications. E7360 A

JOURNALIST REQUIRED for Publicity Department of Midlands engineering concern, for writing technical articles on building, road-making, civil engineering and quarry undertakings. Knowledge of photography an asset. Work partly indoors compiling news sheets and describing new products, &c., and partly in the field writing up plant at work.—Write in confidence, stating age, experience and where gained, salary expected, to BOX No. E1918, "The Engineer." A

JUNIOR DEVELOPMENT ENGINEERS (2) required by Hoover Limited in their Engineering Department. Applicants should have Higher National Certificate (Electrical) or equivalent but man in final year would be considered. The successful candidate will be required to carry out experimental work on domestic appliances. Preference will be given to candidates who have had previous experience in this field.—Apply, stating age, qualifications and experience, to the Employment Officer, Hoover Limited, Perivale, Greenford, Middlesex. E7337 A

MECHANICAL ENGINEERS for service in the East required by old established British Oil Company; age 25 to 30; must have served full apprenticeship in heavy engineering and have H.N.C.; bachelors preferred. Generous terms with cost-of-living allowance: home leave with passages paid both ways: kit allowance: medical attention: free furnished quarters: Pension Fund.—Please write, with full details of age, apprenticeship, qualifications, training and experience to BOX TE.423, c/o 191, Gresham House, E.C.2. E7370 A

METALLURGIST required by National Coal Board's Central Engineering Establishment, Ashby Road, Stanhope Bretby, Near Burton-on-Trent. Applicants should be conversant with the examination of metals using microscopical, ultrasonic and radiographical techniques and be capable of assessing service failures in metals; knowledge of metallurgical analysis would be helpful but is not essential and applicants should be suitably qualified; L.I.M. or equivalent required. Appointment (superannuable), according to qualifications and experience, within range £900–£1400.—Write stating age, qualifications and experience to Personnel Officer (X.1166) at above address before 17th June, 1958. E7372 A

PLASTICS TECHNOLOGIST required by National Coal Board's Central Engineering Establishment, Ashby Road, Stanhope Bretby, Near Burton-on-Trent, for testing and development work on non-metallic materials and the investigation and possible application of new materials, particularly with respect to conveyor belting. Applicants should be conversant with modern laboratory techniques and preferably with the use of physical testing equipment; L.I.R.I. or equivalent required. Appointment (superannuable) according to qualifications and experience, within range £900–£1400.—Write stating age, qualifications and experience to Personnel Officer (X.1167) at above address before 17th June, 1958. E7371 A

PRODUCTION ENGINEER/RATEFIXER wanted for modern electrical engineering company in India, manufacturing electric motors, transformers, switchgear, etc. This factory is at present working entirely on daywork, and an experienced production engineer is required to plan and put into operation a modern individual piecework system in machine shop, fabrication department, winding shop and final assembly. A man with previous experience in India preferred. Emoluments Rs.2100 per month plus free unfurnished living accommodation, medical attention, car allowance and passages out and home, three-year contract in first instance.—Write, stating age, experience and whether married or single, to the Secretary, A.E.I. Overseas, Ltd., Crown House, Aldwych, London, W.C.2. E7294 A

QUALIFIED CIVIL ENGINEER, aged 28/35, required for one tour only of approximately 15 months, for supervision of contracts in BRITISH WEST AFRICA. Applicants should have experience of all aspects of contract administration. Salary, £1900 per annum, plus guaranteed bonus, marriage and children's allowances. Return passage paid. Initial kit allowance, free furnished quarters and medical attention. Life assurance and dependent's income schemes.—Write, giving full details, experience, stating age, married or single, to BOX TE 414, c/o 191, Gresham House, E.C.2. E7347 A

SENIOR AND JUNIOR DRAUGHTSMEN required. Experience in mechanical handling plant an advantage. Good prospects.—British Industrial Sand, Ltd., High Street, Godstone, Surrey. E129 A

SENIOR DRAUGHTSMAN (age 30/35 years) required for permanent position with company of long standing in S.W.1 area, primarily to work on new types of machines in a field differing from the company's other specialised products. A good salary is offered for the successful candidate, who must have good general mechanical experience and H.N.C. or equal. Write, giving full details.—BOX No. E1909, "The Engineer." A

SENIOR METHODS ENGINEER required by an old-established Engineering Group located in the North Midlands and manufacturing own proprietary products, employing 1300 people. The position offered is that of Deputy and Chief Assistant to the Chief Planning Engineer and calls for a trained Engineer, preferably but not essentially holding a Degree in Mechanical Engineering, but must have wide experience in modern precision machine shop practice on medium-sized and large components, made in batch quantities. Applicants should preferably be not more than 40 years of age and should have recently held a similar position. The Group designs and manufactures a range of established engineering products with a wide export and home market. The salary is in the range £1000 to £1300 per annum, with good superannuation benefits. Apply, giving in confidence full details of education and positions held.—BOX No. E1910, "The Engineer." A

STRUCTURAL DESIGN DRAUGHTSMEN required for new section of Design Office. Excellent working conditions, contributory Pension and Free Life Assurance schemes in operation.

Applications to be addressed to: PERSONNEL MANAGER, BLACKBURN (DUMBARTON), LTD., CASTLE ROAD, DUMBARTON E7378 A

Classified Advts. continued on page 130

BOOKS and PUBLICATIONS

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SITUATIONS VACANT

SITE ENGINEERS required for supervision of mechanical and instrumentation work on a large-scale project in the North of England. Duties will include organisation and supervision of direct labour and sub-contractors. Applicants should preferably be Corporate Members of a Senior Institution and have appreciable experience in one or both of the above fields of work.—Write, giving details of age, experience to date, and salary required, to British Oxygen Wimpey, Ltd. (M. and E.), Spadeadam Research Establishment, Near Gilsland, Cumberland. E7357 A

STRUCTURAL ENGINEERS (CONSULTING) invite applications from DESIGN-DRAUGHTSMEN experienced in reinforced concrete or steelwork for a variety of interesting work; 5-day week, two weeks' holiday.—Please state age, experience and salary to Thomas Bedford and Partners, 41, New Bond Street, W.1. E1898 A

TECHNICAL ABSTRACTING AND RESEARCHING. Those willing to undertake part-time work are invited to write stating subjects and if possible charges to BOX No. E7392, "The Engineer." A

WANTED

Experienced STEELWORKS ENGINEER, not over 55 years of age, and preferably with a Degree or professional qualification, for a senior appointment in the engineering organisation of a large Sheffield steelworks. Salary £2000 per annum minimum.—Write in confidence to BOX No. E7385, "The Engineer." A

WANTED, SENIOR JIG AND TOOL DRAUGHTSMAN and MACHINE TOOL DRAUGHTSMAN by company in the South Coast area. Experience in machining light alloys and knowledge of hydraulics and pneumatics an advantage. Write, stating age, details of experience, qualifications, and salary required.—BOX No. E7285, "The Engineer." A

WELL KNOWN ENGINEERING ORGANISATION

in the West Midlands require

A man of the highest calibre for Executive duties which will include the control of Production, and development of organisation.

The applicant should possess a good degree, or equivalent professional qualification, with possibly consultative experience or wide training in Administration in large scale manufacture within the Engineering industry.

Salary will be negotiated to the satisfaction of the right man.—Write for application form to BOX No. E7363, "The Engineer." A

WORKS ENGINEER required immediately for Chemical Works (180 employees) in Selby, Yorkshire. Post involves full responsibility for the maintenance and repair department and for the plant installation and constructional work associated with current expansion. This is an interesting and progressive post in an expanding organisation. Good working conditions, staff superannuation and bonus schemes, assistance with housing if necessary, car provided. Fully qualified chemical engineers, or mechanical engineers with similar experience in the chemical industry, age 30–40, should apply to the Managing Director, John and E. Sturge, Ltd., 1, Wheeleys Road, Birmingham, 15. E7335 A

WORKS ENGINEER required. Duties will involve knowledge of both mechanical and electrical engineering, building, woodworking, boiler plant, and all services connected with the running of a large factory.—Apply, in writing, giving details of experience and salary required, to Technical Director, Kelvin Works, Hackbridge, Surrey. E1901 A

WORKS MANAGER

For well-known West of Scotland Metal Fabrication Company employing 900 personnel.

Applicants, between 40 and 50 years of age, should have an Engineering Degree or equivalent qualification together with practical experience in Mechanical Engineering and/or Steel Fabrication.

Wide experience of modern management techniques is desirable. The successful candidate would be responsible to the General Manager and would carry full responsibility for Works Management, including production planning and control and work study.

Commencing salary in the region of £2000 to £2500 depending on qualifications and experience.

Candidates are invited to write giving full details of qualifications, experience, positions held and salary earned to Urwick, Orr and Partners, Ltd., 86, St. Vincent Street, Glasgow, C.2. E7352 A

WORK STUDY ENGINEERS

Senior and Junior Engineers are required by British Insulated Callender's Cables, Ltd., at Erith Works, Belvedere, Kent. Candidates for senior positions should preferably be of graduate status and have considerable experience in the application of work study to manufacturing processes. Those for junior positions should possess a Degree, H.N.C. or similar qualification, and be willing to undergo a period of training. Good salaries, commensurate with experience and qualification. Excellent prospects. Pension fund and other amenities.—Apply, in writing, to The Staff Officer. E7397 A

YOUNG ENGINEER required by a Company specialising in non-ferrous metals, for handling projects from the design stage on the drawing board, following through to machine construction and running in on the shop floor. A sound practical training and knowledge of engineering services is essential. Experience of non-ferrous metals would be an advantage.—Candidates, who should be between 23–30, should write, giving full details of experience, qualifications, age, &c., to BOX No. E7362, "The Engineer." A

AQUASTAT LTD.

REQUIRE

A TECHNICAL REPRESENTATIVE of high calibre to further the Company's business in the West Country and South Wales. Applicants must be trained engineers with a good sales background.

The Company's plant for preventing hard water scale in heat exchange apparatus enjoys a high reputation and the scope for extending its use is enormous.

The prospects for the right man are unlimited in this young and progressive company.

Suitable applicants are invited to write, giving, in confidence, full particulars of age, qualifications, training and experience and salary expected to:

SALES DIRECTOR,
AQUASTAT LIMITED
Romney House, Tufton Street,
Westminster, London, S.W.1

E7351

SIEMENS EDISON SWAN, LTD.

(AN A.E.I. COMPANY)

MECHANICAL ENGINEERS AND DRAUGHTSMEN,
ELECTRICAL ENGINEERS,
METALLURGISTS,
PRODUCTION QUALITY CONTROL ENGINEERS

TRANSISTORS

Siemens Edison Swan, Ltd., is a newly formed grouping of companies backed by all the resources and facilities of Associated Electrical Industries, Ltd. Vacancies exist for the above on Research, Development and Production of transistors in new premises at Harlow, Brimsdown and Tottenham. Specific principal posts to be filled are:

1. **Senior Development Engineer.** This (Engineer will be required to set up at Tottenham a pre-Production Group within the Engineering Department concerned with the development of Transistors. Qualifications required are a Degree in Physics or Engineering and experience in similar work on Transistors of Thermionic Valves. The preferred age range is 26 to 40 years.
   The successful candidate will be directly responsible to the Chief Engineer, Semiconductors.
2. **Senior Mechanical Engineer/Designer.** An experienced Mechanical Engineer or Experimental Officer grade is required to take responsibility for a Drawing Office and Development Model Shop within the Transistor Engineering Department at Brimsdown.
   An existing group is about to be expanded to provide a service to the Engineering Department for the progressing of devices passing into production stages. Qualifications of at least Higher National Certificate standard are required and experience in similar work in the Electronic Industry is essential. The preferred age range is 30 to 40 years.
3. **Quality Control Engineer.** A Quality Control Engineer is required to take charge of a new group within the technical section of the **Transistor Production Department** at Tottenham.
   The work will be concerned with all aspects of quality production and the section will work closely with the department responsible for transistor development.
   Experience of transistor production whilst desirable is not essential. Engineers having a background of Process Control work in valve manufacture together with a practical knowledge of applied statistics, including Quality Control and design of experiments would be considered suitable candidates.
   A Degree in Physics or Engineering is desirable but not essential. The preferred age range is 26 to 40 years.

In addition to the above a number of supporting vacancies exist in all departments associated with transistors. The conditions of employment are excellent and there are Pension Schemes. Starting salaries, which will depend on age, qualifications and experience, are generous and there is ample opportunity for subsequent advancement. Some assistance may be given to married men in connection with housing.

On THURSDAY, June 12th, FRIDAY, June 20th, THURSDAY, June 26th, between 6 and 9.30 p.m. and on SATURDAY, 21st June, between 10 and 11 a.m. senior executives of Research Laboratories and Semi-Conductor Products Division will be available for confidential discussions and interviews at the

**GREAT EASTERN HOTEL,
LIVERPOOL STREET
STATION ENTRANCE,
LONDON, E.C.2.**

Alternatively, applicants may care to write direct to Mr. A. WHITAKER, Director of Engineering, Siemens Edison Swan, Ltd., Brimsdown, Enfield, Middlesex. E7367 A

WORKS MANAGER

SCOTTISH AGRICULTURAL INDUSTRIES LTD.

invite applications from Engineers for the position of Works Manager of their Scunthorpe Basic Slag Works. Candidates should be 30 years of age or over. The minimum qualification required is Higher National Certificate in Mechanical Engineering. Preference will be given to candidates with experience of ball and tube grinding mills, conveying and sack packing equipment. Experience in the management of a small labour force (about 40) is essential and in the operation of incentive schemes based on Work Study desirable. The post is permanent and pensionable. Salary according to age, qualifications and experience.

Application forms will be forwarded to suitable candidates on receipt of brief details covering age, qualifications and experience, addressed to the Personnel Officer, Scottish Agricultural Industries, Ltd., 39, Palmerston Place, Edinburgh, 12.

E7382 A

COLGATE-PALMOLIVE LIMITED

ORDSALL LANE, SALFORD, 5,

invite applications from

DESIGNER DRAUGHTSMEN

preferably with H.N.C. and with experience of chemical plant layout, service and process pipework. Salary and conditions of employment are good in a modern factory, with excellent accommodation and amenities.—Applications, giving details of age, salary expected, training, qualifications and experience, should be sent to Factory Personnel Manager.

E1916 A

GENERAL WORKS MANAGER

required for the Northern Factory of a Company engaged in light and medium heavy engineering. Exceptional opportunity for qualified mechanical engineer with some electrical knowledge to take charge of design, production and general administration of medium-sized engineering works. Must be first-class organiser. Attractive salary to suitable man who can take charge immediately of growing organisation. Pension scheme and housing assistance.—Full particulars of age, qualifications and experience, to BOX No. E7338, "The Engineer." A

SENIOR DRAUGHTSMEN, DESIGN ENGINEERS

and

DESIGN DRAUGHTSMEN

At our Corby Works, one of the largest integrated Iron, Steel and Steel Tube Works in Europe, we have vacancies for MECHANICAL, ELECTRICAL, CIVIL and STRUCTURAL DRAUGHTSMEN.

The vacancies exist in the New Development Drawing-Offices and the Works Drawing-Offices. The work is interesting and offers scope and opportunity to talented young men.

Applicants with Higher National Certificate and experience in either the Iron and Steel industry or heavy engineering are preferred, but men with Ordinary level and relevant experience, or even unqualified men whose experience is outstanding, would be considered.

In addition to these vacancies, there are openings in other Drawing-Offices elsewhere in the Company.

Five-day week. Good welfare, canteen and recreation facilities. Superannuation and life assurance scheme. Staff hostel for single men. Favourable local housing conditions.

GOOD SALARIES BASED ON EXPERIENCE AND QUALIFICATIONS.

Applications will be treated as confidential and should be made, giving details of age, qualifications, experience, and salary required, to:

Manager/Personnel,
STEWARTS AND LLOYDS, LIMITED,
CORBY, Northants.

E123 A

STOTHERT & PITT LTD., BATH

invite applications from

DESIGNER/DRAUGHTSMEN

with experience in or akin to any of the following
VIBRATING ROLLERS, QUARRYING PLANT, TRUCK MIXERS, CONCRETE MIXERS, ASPHALT PLANTS, CONCRETE BATCHING PLANTS AND ALLIED EQUIPMENT

Local interviews can be arranged but we prefer you to visit our works for a tour of inspection, when all aspects of the work can be seen at first hand. Travelling expenses will be paid to selected applicants. GOOD SALARIES will be paid based on experience and qualifications. Assistance will be given in obtaining housing accommodation where required.

General conditions of employment are excellent. Applications, in writing or by telephone, giving details of age, experience and qualifications, which will be TREATED IN THE STRICTEST CONFIDENCE, should be made to the CHIEF ENGINEER, CONTRACTORS' PLANT DEPARTMENT, STOTHERT AND PITT, LTD., BATH (Telephone: Bath 2277). E7368 A

FACTORY MANAGEMENT

A West London Company specialising in Electronics and Servo Engineering desires to appoint an experienced and efficient Factory Manager.

THE OVER-RIDING QUALIFICATION IS SOUND EXPERIENCE AT SENIOR LEVEL IN THE DIRECTION AND CONTROL OF PRODUCTION DEPARTMENTS IN LIGHT ELECTRO/MECHANICAL ENGINEERING INVOLVING AN INTIMATE KNOWLEDGE OF MODERN TECHNIQUES IN THE MANUFACTURE OF PRODUCTS REQUIRING A HIGH DEGREE OF PRECISION.

Applicants should (preferably) have some professional qualifications and be between 35 and 45 years of age.

The salary will be not less than £2500 per annum. The prospects are excellent and the conditions of service are good, including an established first-class Pensions and Life Assurance Scheme.

All applications will be treated in the strictest confidence and should give date of birth, full details of qualifications; past and present positions, with salaries earned.—BOX No. E7364, "The Engineer." A

SITUATIONS VACANT

PROJECT ENGINEER

REQUIRED by the ENGINE DIVISION of BLACKBURN AND GENERAL AIRCRAFT LTD. BROUGH—EAST YORKSHIRE

PROJECT ENGINEER

The work involved with the post offered is of a varied and interesting nature and primarily covers the industrial application of small Gas Turbine Engines.

The post is for a Senior Engineer preferably with experience of industrial projects. Minimum qualification, Higher National Certificate.

Good working conditions are offered with Pension Scheme. Assistance with housing can be arranged. All applications will be acknowledged and treated in the strictest confidence.

Apply giving full particulars to :
Design Office Manager,
Engine Division,
Blackburn & General Aircraft, Ltd.,
Brough, E. Yorks.

E7201 A

SENIOR DRAUGHTSMEN

preferably experienced in bulk mechanical handling or excellent opportunities exist for draughtsmen with good knowledge of lighter handling equipment to gain experience of the heavier industrial plants. Superannuation scheme. Five-day week. Appointment by telephone or letter to MARCO CONVEYOR & ENGINEERING COMPANY, LTD., Lynn Road, Leytonstone, London, E.11. LEY. 2254.

E7309 A

SITUATIONS WANTED

MECHANICAL ENGINEER (42), A.M.I.Mech.E. Experienced design oil and chemical industries, boilers, aircraft, jigs and tools. Thorough knowledge pressure vessels. Presently holding senior appointment but wish scope further advancement.—BOX No. E1919, "The Engineer." B

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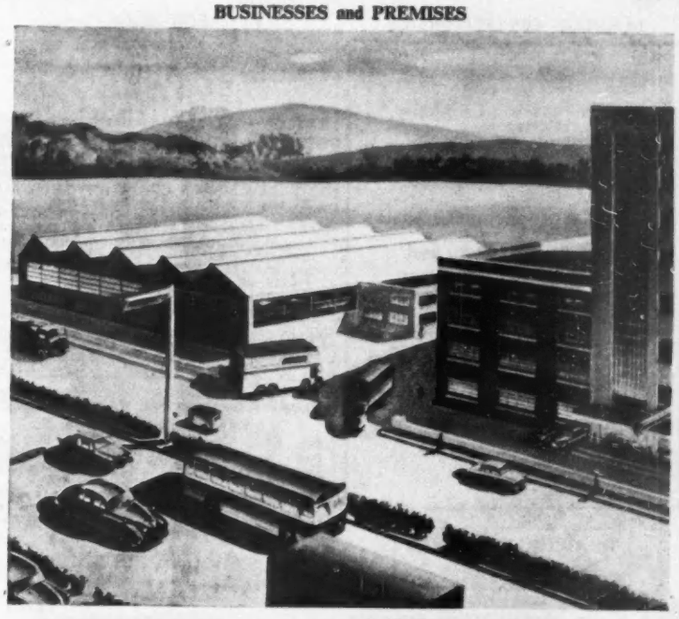

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Classified Advts. continued on page 132

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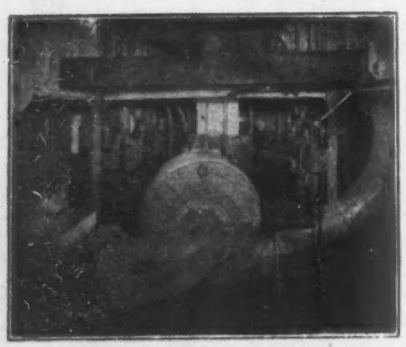

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AUCTION PROGRAMME

		Main Location	*Auctioneers*
June 10–13	Vehicles, machine tools and miscellaneous stores, including binoculars, textiles, cold stores, etc.	M.O.S. Storage Depot, Royal Arsenal, Woolwich, S.E.18.	FULLER, HORSEY, SONS & CASSELL (Dept. L), 10, Lloyd's Avenue, London, E.C.3. (Tel.: Royal 4861.)
June 17–19	Machine tools and miscellaneous stores, including M/T spares, textiles, etc.	M.O.S. Storage Depot, Ruddington, Notts.	WALKER, WALTON & HANSON (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel.: 47271.)
June 20	Miscellaneous stores, including boots, shoes, scrap canvas, hand tools, etc.	Command Ordnance Depot, Coypool, Marsh Mills, Plymouth. (Sale at Kinterbury House.)	WOOLLAND, SON & MANICO (Dept. L.) Kinterbury House, St. Andrews Cross, Plymouth. (Tel.: 65356.)
June 24	Miscellaneous stores, including :— canvas, blankets, hessian, rags, tentage and webbing, boots, berets, caps comforter, caps G.S., greatcoats, jerkins, pullovers, canvas shoes, shirts, socks, ties, battle dress trousers, vests, old batteries, tyres, chairs, tables, haversacks, packs, kitchen utensils, welding rods, gravity roller, weighing machines, paint, and M.T. tools.	Northern Command Ordnance Sub Depot, Barlow, Nr. Selby, Yorkshire.	BARTLE & SON (Dept. L), 50–52, Merrion Street, Leeds, 2. (Tel.: 20898.)
June 25–27	Miscellaneous stores,	Central Ordnance Depot, Didcot, Berks.	SIMMONS & SONS (Dept. L), 12, Station Road, Reading, Berks. (Tel.: 54025.)
July 2	Machine tools and miscellaneous stores	Technical Stores Sub Depot, Old Dalby, Melton Mowbray, Leics. (Sale at Melton Mowbray.)	SHOULER & SON (Dept. L), 1, Norman Street, Melton Mowbray, Leics. (Tel.: 81.)
July 7–11	Passenger and load-carrying vehicles, earth-moving and lifting equipment and their ancillaries and spares	M.O.S. Storage Depot, Ruddington, Notts.	WALKER, WALTON & HANSON (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel.: 47271.)

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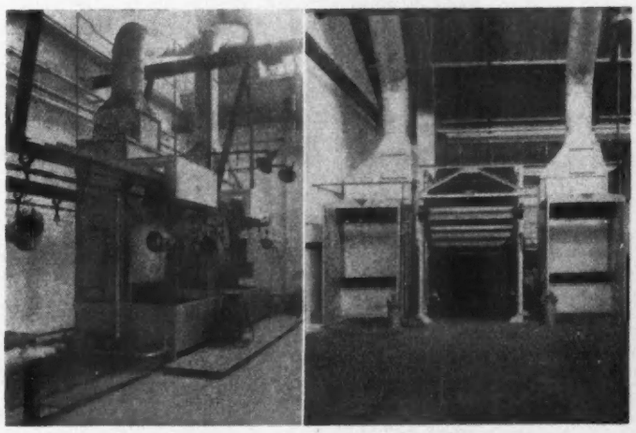

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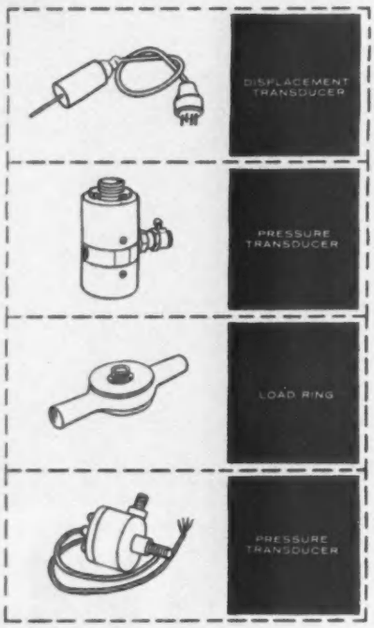

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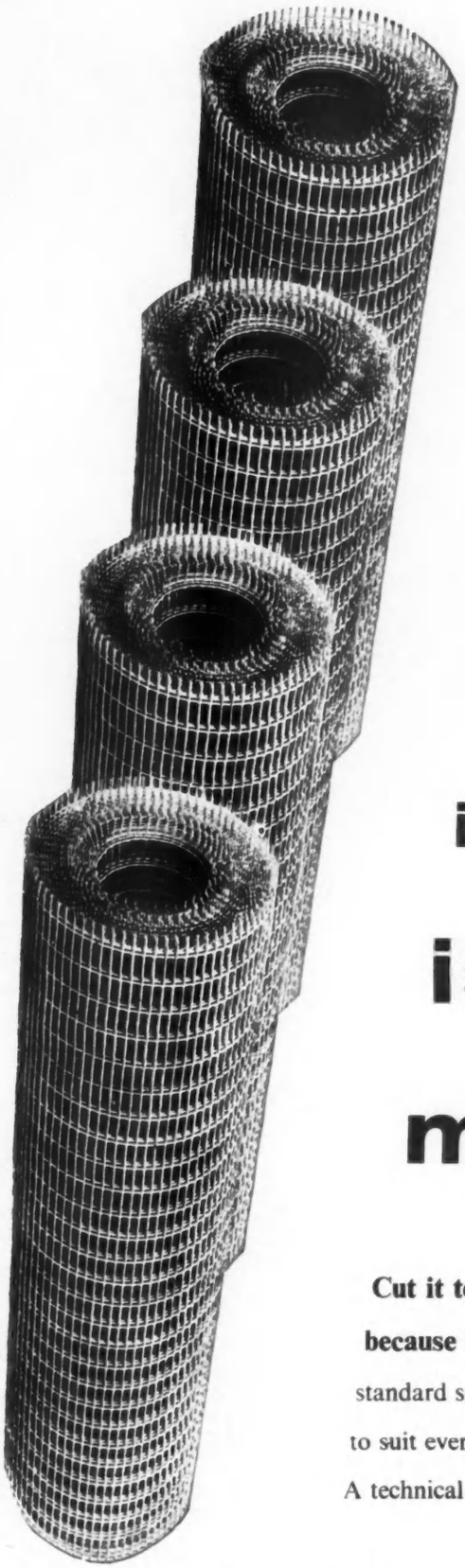

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